ANNALS

OF

SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

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VOLUME LVI

JULY—DECEMBER, 1912

PHILADELPHIA

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1912

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ANNALS OF SURGERY

VOL. LVI JULY, 1912 No. 1

ORIGINAL MEMOIRS.

NEPHRECTOMY.*

A STUDY BASED ON THE RECORDS OF 112 CASES.

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IF we consider the enormous quantity of successful work done on the human kidney at our time, it is noteworthy to remember, that the birth of modern renal surgery dates back only to 1869, that is a little more than 42 years, when, to cure an abdomino-ureteral fistula, Gustav Simon of Heidelberg deliberately and successfully removed a healthy kidney. The momentous step was undertaken only after the question, namely, whether the human organism could survive the loss of this organ, had been carefully investigated both in the light of clinical experience, but mainly by animal experiment.

The material for this paper (with one exception,—a case of renal echinococcus †) has been collected from the records of the First Surgical Division of Mt. Sinai Hospital, which I have the honor to direct. It comprises a term of 16 years, beginning in 1895 and ending with December, 1911. The documentary proofs are accessible in the following places:

1. In a "Contribution to the Surgery of the Kidney and

* The President's Address, American Surgical Association, May 29, 1912.

† From my former service at the German Hospital, New York City.

Ureter," *American Journal of Medical Sciences,* June, 1897, p. 677.

2. In the *Mt. Sinai Hospital Reports,* volumes i, ii, iii, iv, and v.

3. In the bound volumes of the original Mt. Sinai Hospital Records (of case histories) of the First Surgical Division (unpublished).

Roughly, the material may be divided into the following groups:

	Cases.	Deaths.	Percentage of mortality.
Pyonephrosis	61	9	14.75
Tuberculosis	20	4	20.00
Hydronephrosis	11	3	33.33
Neoplasms	18	8	44.40
Echinococcus	2	0	
Polycystic disease	1	0	
Total	112	24	

Total mortality, 21.33 per cent.

Note.—The great majority of operations herein reported were done by the author. A smaller number were performed under his authority by the associates and adjuncts who were and still are attached to the service: Drs. Lilienthal, Van Arsdale, Berg, Moschcowitz, Beer, and Lewisohn.

GENERAL CONSIDERATIONS.

Diagnostics.—Those who were in active practice before the advent of cystoscopy will remember the diagnostic uncertainties and anxieties of the surgeon, when, having determined upon the removal of one kidney, he had to face the question of the functional capacity of the other kidney. The clumsy and unreliable expedient of laparotomy for ascertaining by touch the presence, size, and nature of the mate of the diseased organ, had to be resorted to, and many times risks had to be taken, which nobody would consider justifiable to-day. To-day, as a matter of routine, the physical examination is completed in the generally accepted manner by catheterization of both ureters. Radiography is regularly employed, not only to ascertain the presence of calculi but also to throw

light upon the relations of a lumbar tumor to the stomach and the large intestine. The general condition of the patient is carefully gone into, and, in the presence of complicating troubles, the chances of the operation are well weighed. When the hæmoglobin test indicates less than 30 per cent., no operation is undertaken if the anæmia is due to neoplasm or to a chronic form of suppuration; if on the other hand it is the consequence of recent copious hemorrhage, nephrectomy as a hæmostatic life saving measure is unhesitatingly done. Case IV, page 9, shows that in the presence of a hæmoglobin percentage of 21, nephrectomy saved the patient's life.

Preparation of the Patient.—The preparative measures employed were those usual before major abdominal operations. The skin of the lumbar and hypochondriac regions was shaved, scrubbed with soap-suds and a gauze mop, then washed with ether and a watery sublimate solution of 1 to 500. The posture was lateral, bringing the field of operation uppermost, the patient's knees being bent at a right angle; this to counteract the tendency to the prone posture. Formerly a large and hard, cylindrical horse-hair cushion was inserted under the waist of the patient for the purpose of producing a certain degree of lateral curvature of the spine, which determined a protrusion of the loin. Nowadays this aid is secured by a special attachment to the operating table, worked by crank and ratchet. To facilitate easy approximation of the edges of the wound for suture, this elevation of the loin is dispensed with at the end of the operation.

The Grossich method of disinfecting the skin with tincture of iodine was only used in emergency cases.

Exposure of the Kidney and Vessels.—Among the many modifications of the original Simon incision, none has proven as useful as the oblique one, beginning where the outer edge of the sacrolumbalis muscle overlaps the twelfth rib, and running downward and forward diagonally across the lumbar space toward the crest of the ilium, the inclination and length of the incision depending upon the situs and size of the organ. The obliquity of this line runs parallel with the

twelfth intercostal nerve and artery, injury to which is thus easily avoided. The muscles are divided down to the transversalis fascia. When this is divided, the fatty capsule of the kidney comes in view. When dealing with a suppurating or tuberculous kidney, or with a new growth, it is very advisable not to proceed any further before having ascertained the exact place of the peritoneal reflection, and this for several good reasons. In handling a kidney distended by pus, it is a very frequent occurrence that abscesses are ruptured, their escaping contents soiling the wound. In the presence of close adhesions, such a rupture may happen simultaneously with tearing of the peritoneum, and peritoneal infection may follow, *especially when the surgeon is not aware that the peritoneum was actually rent.* Such an undetected injury to the peritoneum constitutes, in fact, one of the most serious accidents that may happen in the course of nephrectomy. With the peritoneum well recognized and in full view, its injury is immediately noticed and remedied by suture or packing.

The exposure of the peritoneum has another great advantage. It may be incised, and the relations of a large tumor may thus be exactly gauged by palpation and inspection. But the greatest advantage consists in this, that exposure of the retroperitoneal space opens up the direct route to the renal vessels. Early in the sixties of the last century, Langenbeck laid down the sound principle, that in the excision of large tumors holding close relations to important vessels, before attempting the dissection of the tumor, the surgeon's first duty should be to reach and lay bare its principal blood supply, so as to protect himself against accidental hemorrhage. The absolute value of this simple principle was proven to me so many times under otherwise formidable circumstances, that I do not hesitate to recommend its use in the strongest terms, especially where a large solid tumor of the kidney is to be removed.

There is another point I wish to mention. Sometimes the peritoneum, which is adjacent to the anterior aspect of the

kidney, is so closely adherent to the tumor, that it is impossible to separate it without tearing the kidney and contaminating the wound and peritoneal cavity with escaping matter. In such a case it is imperative to excise the adherent peritoneum *en bloc* with the mass. This early exposure of the relations of the diseased organ with the peritoneum will at once clear up the situation, will enable the surgeon to circumcise the adherent peritoneum, and to close the peritoneal cavity either before or after the deligation of the renal vessels, thus guarding both against accidental hemorrhage and against accidental pyogenic or neoplastic infection. To the observance of this rule may be attributed the fact, that in not one of the cases herein reported, was post-operative peritonitis observed.

The relations of the kidneys to the hepatic and splenic flexures of the colon have not only a great diagnostic value, but must receive attention during the progress of nephrectomy for neoplasm. I have found that the hepatic flexure has rarely caused trouble, as it is generally found to be displaced downward, well out of the operative field. The left kidney, however, with its normal situs somewhat higher than that of its mate and with the splenic flexure fixed to the diaphragm, is found as a rule holding intimate relations with the last part of the transverse colon, which may adhere very closely to the anterior surface of the kidney. An illustration of this circumstance may be found in the history of Case XXXVIII, page 39.

Here, as well as in all cases where the entire kidney or its upper pole lies hidden behind the lower ribs, additional incisions may be required to permit of a safe procedure. To this we shall shortly return. For the present let us say then, that the primary exposure and identification of the peritoneal reflection is advisable in all cases; it is necessary whenever we are dealing with a suppurating kidney, and is of the utmost use, where the great size of a renal new growth demands circumspection in gauging adhesions to adjacent tissues and organs, and the preliminary securing of the renal vessels indispensable. It is evident that the oblique incision will readily admit safe handling of adhesions of the fibrous to the fatty

capsule about the lower pole of the kidney. It is otherwise with those situated at the upper pole. Extreme variations are observed in the height of the situs of the kidneys in reference to the lower segment of the thoracic skeleton. Sometimes, even in deep anæsthesia, it is impossible to palpate a kidney of normal size, and indeed, a kidney tumor of considerable size may not be palpable on account of its high situs. In one of our cases auscultation demonstrated that the diaphragm was displaced upward, percussion showing that a large area of dulness existed below it. This, together with the findings of cystoscopy, justified the conclusion that the kidney, though not palpable, was much enlarged.

To expose the upper pole in such cases, a vertical subsidiary incision was added to the oblique one, running according to necessity in about the scapular line upward across one, two, or even three ribs. This vertical incision divided the muscles down to the ribs, permitting free lateral retraction, by which two or three inches of the rib were exposed. Subperiosteal resection of the rib or ribs having liberated the costal border, the pleural sinus became thus mobilized and was readily drawn upward out of the way. A moderate amount of care sufficed in most cases to prevent injury of the pleura. Should this occur however, the accident is not of great importance, and its significance has been greatly exaggerated. Pressure with a pledget of moist gauze will stop leakage of air for the time being, and a suture will secure the rent at the end of the operation. We have never seen serious consequences following limited pleural injury, and in one case of calcifying echinococcus of the kidney, where a considerable area of the adherent pleura had to be taken away with the rigid sac,[1] the momentary collapse of the lung was overcome by plugging and artificial respiration.

Accidental and Secondary Hemorrhage.—Accidental arterial hemorrhage during the progress of nephrectomy occurred once.

[1] Contribution to the Surgery of the Kidney and Ureter, American Journal of Medical Sciences, June, 1897, p. 677.

CASE I.—*Hemorrhagic infarct of left kidney following catheterism. Nephrotomy; no improvement. Nephrectomy; slipping of ligature from pedicle, arterial hemorrhage, clamping, religature, cure. Specimen: total parenchymatous necrosis of kidney.* (Contribution, *loc. cit.*, p. 691.)

Mrs. S. S., age thirty-four, suffered since years from urinary troubles, requiring occasional catheterism. December 7, directly after use of catheter, was suddenly seized with acute, cutting pain in left loin, followed by severe rigor, high fever, radiation of pain to left thigh, and much vomiting. On admission, December 13, 1896, temperature 104° F., continuous desire to urinate, though the bladder was empty, small rapid pulse, vomiting; in the left loin a large very tender tumor. Urine scanty, 1022, containing a few white and red blood-corpuscles and a trace of albumin. Immediate nephrotomy; circumrenal fat turgid, œdematous, kidney very much enlarged, capsule tense; after its incision the dusky and very brittle parenchyma protruded in the manner of a hernia. Freely incised, *it did not bleed,* but yielded only quantities of turbid dark red serum. In digitally dilating the aperture made into the pelvis, some tissue gave away to slight tension, when profuse arterial hemorrhage followed. This was controlled by small tampon. The kidney was stripped out of its capsule, was surrounded by a moist pack of gauze, and the pelvis was drained by a tube. There followed immediate cessation of the exquisite local pain, but the fever and vomiting persisted. Copious serosanguinolent oozing that generally follows nephrotomy was absent, dressings remaining strangely dry. Strangury also persisted. December 20, first packings being removed, renewed arterial bleeding followed by the escape of thick pus from the renal pelvis. Renewed packing stopped the hemorrhage. By January 7 daily quantity of urine had risen from 16–18 oz. to 60 oz., and as under a hectic fever the patient was losing ground, nephrectomy was done. It was observed then, that the enormous swelling of the kidney found at nephrotomy had disappeared, and that the size of the organ had shrunken to the subnormal. Moreover it was flabby and unusually brittle. An abscess broke near the pedicle, which was very short and inaccessible. When the kidney had been cut away, the mass ligature either cut through or slipped off, and this was followed by a frightful gush of arterial blood. However, digital

compression luckily controlled the flow until all the blood was mopped away, so that a large clamp could be applied under the guidance of the eye. Then the stump was religatured and the entire wound packed and left open. Ligature came off January 29. Discharged cured February 25. All the parenchyma of the kidney was necrotic and in a state of disintegration.

Accidental venous hemorrhage was observed twice.

CASE II.—*Tuberculosis of right kidney. Nephrectomy. Tearing of renal vein. Hemorrhage. Death.* (*Hospital Records,* 906–7, vii, p. 837.)

Lizzie D., age forty-two, Russian. Admitted, June 18, 1907. Six months ago began to have frequent and painful micturition, two months ago bloody and purulent urine. Had lost 30 pounds in weight. No lumbar pain. Marked emaciation and anæmia, lungs free; on admission, in right loin more resistance to deep palpation than in left, no tumor felt. June 19: Cystoscopy. Both ureteral orifices normal. Right side of trigonum studded with ecchymotic patches. Catheters passed easily. Urine from right kidney loaded with tubercle bacilli. June 21: Nephrectomy. Typical procedure. Ureter divided, artery tied securely. In tying the stretched renal vein, the vessel gave way in the line of the ligature. Immediate compression controlled the hemorrhage, so that not much blood was lost. Vein was clamped near its entrance into vena cava. Wound packed. The patient had become deeply shocked. An intravenous infusion slightly improved the pulse, but this was of short duration and the patient expired 30 minutes after the conclusion of operation.

CASE III.—*Calculous pyonephrosis of right side. Primary nephrectomy. Hemorrhage due to tearing of pedicle. Suture-ligature. Cure.* (*Hospital Records,* 1905–6, vii, p. 639.)

Lena G. R., age thirty-four, housewife. Admitted May 22, 1906. About ten years ago attacks of severe right lumbar pain, radiating to bladder, which came and went for about two years. Since then a dull ache persisted; there was bloody urine at times. Urination painful but not frequent. On admission: General condition good. Temperature slightly febrile, pulse 72–110, urine amber, turbid, 1020, loaded with pus and some red blood-cells. Abdomen, lax, easily palpable. Kidneys cannot be palpated, pres-

sure in right loin not painful. May 23: Cystoscopy. Right side of trigonum and bladder wall coated with adherent pus; mucosa injected with hemorrhagic patches. Both ureteral catheters easily passed; from right side semisolid purulent material escaping, from left side clear amber urine. Urine: right side yields only thick pus; left side, clear, pale amber, 1020, urea 1.7 per cent., a few pus- and red blood-cells. May 24: Primary nephrectomy. The high situation demanded resection of twelfth rib. Easy separation of numerous adhesions, elastic ligature of pedicle. In dividing tense pedicle, a portion of its proximal side was torn, profuse hemorrhage following. But the stump was caught in a clamp and was secured by a double ligature passed through its base by means of a needle. The kidney was a pus sac devoid of parenchyma. Uninterrupted recovery. Discharged cured June 18, 1906.

Epicrisis.—When securing a pedicle containing large vessels, it is best to tie and divide the vein first, and then the artery. The opposite procedure is apt to put too much tension on the delicate walls of the vein, which, unduly stretched, may easily be cut or rent by the ligature.

Secondary post-operative arterial hemorrhage following seven days after nephrotomy was observed once, necessitating nephrectomy.

CASE IV.—*Non-septic hemorrhagic infarcts of right kidney. Nephrostomy drainage. Secondary renal hemorrhage seven days after operation. Revision and resuturing of kidney. Renewed hemorrhage. Extreme anæmia. Nephrectomy. Syncope. Recovery.* (*Hospital Records,* 1905–6, vii, p. 713.)

Paul B., age twenty-eight, Russian, storekeeper. Admitted June 15, 1906. Fourteen months ago hæmaturia with vomiting and severe pain in right loin radiating to penis, but no chill or fever. Since then no hæmaturia, but a constant dull pain, frequently accentuated to paroxysms with vomiting. During the attack very frequent and painful voiding. On admission, poorly nourished. Temperature 99° F., pulse 80. Neither kidney palpable, no lumbar pressure pain. Urine: Bloody, 1008, acid. June 17, cystoscopy: Left side, 1032 and trace of albumin, a few red blood-cells. Right side, 1024 and loaded with blood. Both

catheters had been easily passed into pelves. Radiograph negative. June 21: Exploratory nephrotomy. Extensive adhesions of fatty capsule to fibrous coat. Kidney developed. Palpation negative. Long incision (with knife) along convexity down into pelvis. No gravel or stone found. A segment of parenchyma being excised, the pelvis was drained with a small tube and the kidney was sutured by a number of deep and superficial sutures. Little reaction followed. June 28, profuse hemorrhage both through drainage tube and into bladder, from which massive clots were washed out with much difficulty. June 30: Hæmoglobin down to 27 per cent., still bleeding. July 1: Revision of kidney wound. Reopening of wound and redelivery of kidney. No hemorrhage followed. Therefore the kidney sutures were left intact, but five more deep sutures were passed through the parenchyma. The kidney was replaced and the wound packed to the bottom with considerable pressure. July 2: Hæmoglobin 21 per cent., and the hemorrhage still continuing. Nitrous oxide anæsthesia. Rapid nephrectomy; elastic mass ligature. Deep syncope with stoppage of breathing overcome by artificial respiration and intravenous stimulation. Specimen: a number of old white infarcts, the contents of some of which (the largest one two inches in diameter) were disintegrated and replaced by clotted blood. Slow recovery. Discharged cured August 25, 1906.

Management of Fatty and Fibrous Capsules.—Heretofore, little attention was paid by authors to the management of the fatty capsule, except as one of the barriers to be overcome during the exposure of the kidney. The condition of the fat itself may have a diagnostic value. In sudden and stormy infectious processes, such as are the acute septic hemorrhagic infarct, acute septic parenchymatous nephritis, acute gonorrhœic nephritis, in short, whenever a marked acute swelling of the parenchyma produces great tension of the fibrous capsule, we find invariably the renal fat in a state of pronounced acute œdema. In chronic processes on the other hand, such especially as calculous disease or tuberculosis of old standing, we find the fat has disappeared,—sometimes entirely, nothing remaining but a sparse network of thin connective tissue, here and there, or in its entirety condensed into

extremely tough and resistant adhesions between the fibrous capsule, the peritoneum, the diaphragm, and the transversalis fascia. These adhesions then offer almost insurmountable difficulties to the safe removal of especially such kidneys as have undergone partial or total suppurative liquefaction. In tuberculosis, but especially in cases of malignant neoplasms, the fatty capsule,—in conformity with the general rule,—ought to be removed *en bloc* with the diseased kidney. Where the tumor is of moderate size, this can be accomplished with little difficulty through a generous incision, and the step will carry a valuable guaranty against relapse, especially where the new growth is still confined within the limits of the fibrous capsule.

In tuberculosis, whether or not perforation has occurred, tc gain security against recurrence, it would be rational to remove the infected fatty and fibrous structures. Where the disease is of recent standing and still intracapsular, the task is feasible; but where the process has advanced to the formation of abscesses in the cortex, such an attempt may cause much mischief. It may lead to rupture and to contamination of the wound, of the peritoneum, or pleura even before the vanity of the undertaking had become manifest. Such unsuccessful efforts, after much loss of time and the infliction of futile traumatism, leave the wound in a sorry mess, and engender bad results.

The adhesions binding down the kidney in cases of pyonephrosis of old standing are just as firm, short, and unyielding as in tubercular mischief. As this class of cases comprises more than one-half of the maladies demanding nephrectomy, it is fortunate that we have a ready expedient, which enables us to evade the dangerous necessity of battling with close adhesions. This expedient is known as the *subcapsular procedure*. Whenever it becomes evident that division of the adhesions at the upper and lower poles of the kidney would involve tedious and risky dissection, rupture of a pus sac, and simultaneous injury to the soiling of adjoining large cavities, the subcapsular method should be adopted. The

exposed surface being well protected by packings, abscesses located near the surface of the kidney should be first emptied either by trocar or by incision. Then the fibrous capsule having been split along the entire length of the convexity, is rapidly stripped off to the pelvis, upon which it becomes reflected back, so that a more or less massive pedicle is formed containing vessels, the pelvis, and sometimes the ureter. Around this is thrown an elastic ligature of solid rubber, and the kidney is cut away on the distal side. Sometimes it will be found unavoidable to lay this incision through the parenchyma itself, so that parts of the kidney tissue will still compose a portion of the terminal parts of the stump. But as this must slough away, no fear need be entertained that secreting tissue will be left behind to cause a permanent urinary fistula, unless secreting tissue has remained standing on the proximal side of the ligature. In a difficult case not included in the present series (it had occurred before 1895) where the pedicle was extremely short, this very accident was encountered. Kidney tissue had been left behind on the proximal side of the elastic ligature. The patient did well, but a urinary fistula remained, which was cured by the secondary excision of a small remnant of parenchyma.

For obvious reasons the subcapsular method should not be employed in tuberculosis; occasionally, however, this will be unavoidable. Among our cases there was one in which the expedient was of notable service; but the course of healing was not devoid of the consequences of leaving behind diseased tissue.

CASE V.—*Tuberculosis of dystopic right kidney. Subcapsular nephrectomy. Cure.* (*Hospital Records,* 1909–10, x, p. 1456.)

Rose E., age twenty, shop-girl, Russian. Admitted October 23, 1909. Two and a half years ago began to suffer from sharp attacks of pain in right iliac region, accompanied by chills and fever. No urinary symptoms. In March, 1908, was operated upon at another hospital for appendicitis; was told afterward that she had a displaced kidney which was "hitched up" (?). Continuance of attacks of chills and fever. After this operation

urination became frequent and painful, the urine always turbid, sometimes bloody. Five weeks ago an attempt had been made in same hospital to remove the kidney, but was abandoned on account of great hemorrhage. Had become emaciated from nightly fever and profuse sweats. On admission: Poor general condition, temperature 103°, pulse 116. Lungs and heart negative. In right iliac fossa a large, tender, and fixed tumor of kidney shape; right loin empty. Urine: amber, turbid, alkaline, 1012, no tubercle bacilli, but amorphous phosphates and pus cells. Cystoscopy. Bladder contracted, capacity 90 c.c. Mucosa normal. Right ureteral ostium œdematous and deeply congested. Catheter passed readily into pelvis of left kidney and discharged abundant, clear urine. Introduction of catheter into right ureter needed considerable manipulation; was arrested at 13 inches; it discharged thick pus of fecal odor, no urine. October 26, subcapsular nephrectomy: Long incision along crest of ileum to Poupart's ligament; peeling up of peritoneum until tumor was reached. Incision of peritoneum for exploration and ascertainment of the fact that the tumor was the kidney. Difficult separation of about half of the circumference of the tumor from the rim of the small pelvis, where it was densely attached. Splitting and stripping of fibrous capsule, which act opened and discharged several abscesses. Elastic ligature to short pedicle. Dystopia was ascertained to be congenital, due to low origin of renal vessels. Suture of peritoneal incision; drainage and closure of external wound. Pathological report, renal tuberculosis. Slow healing of wound. Ligature came away on twenty-fourth day. Repeated revisions of the wound became necessary on account of the slow and irregular healing, due to tubercular infection of the granulations. January 16, 1910, patient had grown fat and rosy, was discharged cured.

Note.—The scar broke down twice in the course of the year, but ultimately healed firmly. Patient was seen November 2, 1911, in excellent condition.

Management of Pedicle and Ureter.—To complete our remarks on mass ligature by a solid rubber cord, a few facts are to be added. The thickness of the cord should be one-sixth of an inch; this will be strong enough for the heaviest pedicle. It should be pure gum of the best quality, and ought to be

carefully tested before use. In an emergency pure gum rubber tubing (of black color) may be used. The mode of application is as follows: A piece of about 12 inches in length is passed around the pedicle as high up as possible in such a manner, that the middle of the cord will be in contact with the pedicle. Thus each half of the cord will be held by one hand of the surgeon. While an assistant supports the kidney, the surgeon should steadily and firmly stretch the two segments of the cord, and maintaining the tension should cross the two "legs" of the band, the crossing point being in close proximity to the pedicle. At this point another assistant will pass a short piece of stout silk ligature under the point of crossing of the two halves of the rubber cord. Now the surgeon, still maintaining tension, will increase the angle at which the two ends of the cord were held to about 120 degrees, whereupon the silk ligature is firmly tied and the tension of the cord released. The result will be, that the parts of the cord thus released will shorten, thicken, and will crowd up against the silk ligature, while the segment confined within the silk ligature and embracing the pedicle will remain at utmost tension. It cannot slip, it will remain tense to the end, while slowly cutting through the pedicle, and is the simplest and most dependable form of ligature known. It is far preferable to silk or catgut, both of which soon become loose if applied to a stout and œdematous pedicle. The simple method of securing the rubber band with a silk ligature was tested by me hundreds of times without accident, and is much better than a knot tied in the rubber cord itself. It is especially useful where a pedicle of extreme shortness cannot be exposed to sight, and where the trick must be done in the depth of a narrow cleft. The ends both of the rubber cord and the silk ligature are brought out through the angle of the wound left open for drainage. The ureter, if included in the band, will take care of itself. The length of time required for the coming away of the rubber ligature varied between 12 and 36 days, the length of period depending upon the thickness and solidity of the structures composing the pedicle. The

rubber cord was never employed where the pedicle was easily exposed, when the vessels were isolated and tied separately with catgut. In these cases the ureter was also separately ligatured and cut off. Where, in cases of tuberculosis, the ureter was found to be manifestly diseased, it was dissected down close to the bladder, tied off, and removed.

Drainage and Closure of Wound.—The extent of the measures to be taken for drainage will have to depend not only upon the extent of the wound cavity and the amount of traumatism inflicted, but mainly upon the question, whether or not during the progress of the operation any purulent soiling of the wound had occurred. Where the procedure was simple and uncomplicated, it sufficed to place one or two cigarette drains into the recesses of the wound, bringing them out by the posterior angle. Where contamination by rupture of abscess led to soiling, measures were more comprehensive, each angle receiving a drainage tube. Sometimes we lined the whole cavity with a square of gauze, which was then filled according to Mikulicz's plan with a number of separate compresses. At any rate, it is safer to drain more than less where pus has escaped, especially in cases of tuberculosis. Even after the exercise of utmost circumspection, we have had to incise and empty secondary abscess developing along the course of the ureter. Where the healing was sweet, the drains were gradually shortened and withdrawn. It may be said in general, that leaving in a drain one or two days longer than necessary never did any harm, while withdrawing it too soon was invariably followed by trouble.

Where the patient's condition remained good to the end of the operation, the fascial and muscular structures were reunited by two rows of buried chromicized catgut sutures well up to the posterior angle and to the drainage. The skin was brought together with a row of fine silk sutures. Where it became necessary, the more summary method of applying through-and-through silk sutures was resorted to and gave equally good results. Though stitch-hole suppuration was occasionally observed, a breakdown of the entire suture line has happened very rarely.

After-treatment.—The after-treatment was governed by the principles observed after laparotomy, special attention being paid to the amount and quality of the urinary secretion. Proctoclysis while post-operative vomiting persisted, afterward copious draughts of liquids were administered to stimulate the action of the remaining kidney. Invariably enough morphin was given to allay pain, and in no case could ill effects of any kind be conscientiously attributed to its adequate and humane administration. In the absence of complications the patients were gotten out of bed as soon as firm union of the wound was assured, that is on an average on about the tenth day, and this without reference to whether a mass ligature had come away or not. In only one case did the patient return with a lumbar hernia, which had been caused, not by suppuration, but undoubtedly by accidental injury to the nerve supply of the muscular parietes.

PYONEPHROSIS.

Statistics.—Nephrectomy was done for pyonephrosis from all causes in 61 cases. In these the right kidney was concerned in 42, the left one 19 times, operations on the right kidney more than doubling those on the left.

	Cases.	Deaths.	Percentage of Mortality.
Calculous pyonephrosis, primary nephrectomy.....	17	2	11.8
Calculous pyonephrosis, secondary nephrectomy.....	14	4	28.5
Combined mortality			19.3
Non-calculous pyonephrosis, primary nephrectomy...	13	1	7.7
Non-calculous pyonephrosis, secondary nephrectomy.	17	2	11.7
Combined mortality			9.7
Primary nephrectomies for all causes.....	30	3	10.0
Secondary nephrectomies for all causes.....	31	6	19.35
Total for all nephrectomies for pyonephrosis from all causes	61	9	14.75

Among these there were two cases of dystopic kidney, one calculous (died), and one of hemorrhagic infarct (recovered). Altogether, there were done 9 nephrectomies for hemorrhagic infarct (8 septic, 1 non-septic), which all ended in recovery except one, a septic case.

Note.—As all the cases of infarct, except one, were of a septic and destructive character, they were, for the sake of simplifying the statistical table, included under the heading of pyonephrosis.

Examination of the table will suggest many paths for reflection. It must suffice to call attention to its most salient features. The most important one is this, that roughly speaking the mortality following secondary nephrectomy was twice as large as that subsequent to the primary operation.

In at least two of the fatal cases of secondary nephrectomy (Hospital Reports, 1901, p. 320, Philip E. and Hospital Records, 1909–10, x, p. 1478) it must be admitted that it was an error not to extirpate at once rather than merely to drain the kidney. I now believe that here primary ablation would have offered a better chance of success. But it must be said, that in two of the cases death was due to uræmia, in one coming on long after the discharge of the patient, caused by the diseased condition of the remaining kidney. Furthermore, the study of our histories will demonstrate, that in almost all of the cases of secondary nephrectomy (including patients recovered and dead), the patient's condition at the time of the primary nephrotomy was so precarious, that even this, the milder procedure, constituted a very great risk. It is plausible to assume that had primary nephrectomy been insisted on in all cases (except the two cited above), a good number of those patients would have succumbed, who survived both the milder primary and the severe secondary operation. Therefore it would be very rash to conclude that primary nephrectomy is the safer operation under all circumstances.

The following history is typical for illustrating the necessity for discrimination, where the patient's general condition is very bad.

CASE VI.—*Calculous pyelonephritis of the left side. Nephrotomy. Extraction of large calculus. Drainage. Late nephrectomy. Cure.* (*Hospital Records,* 1899, p. 205.)

Amalia Z., age twenty-eight, admitted July 1. Difficulties of urination since childhood. Since three years urine turbid and offensive. Was recently delivered of child. In May began to feel acute pain in left loin with periodical attacks of high fever, and had become very anæmic and frightfully emaciated. Urine loaded with thick, ropy masses of pus, acid, fetid; no casts, no sugar, traces of albumin. In the left loin a smooth, movable, painful, non-fluctuating mass, extending to the level of the umbilicus. Right kidney palpable, not enlarged, nor painful. Other organs normal. July 2: Nephrotomy, evacuation of a large quantity of fetid pus, and of a uratic stone, two and a half inches long, three-quarters of an inch thick, bifurcated at one end and tapering at the other. Drainage. Though no parenchyma was left, patient's weakness demanding haste, nephrectomy was refrained from. It was expected that establishment of drainage, an easy matter in a simple uncomplicated sac, would lead to cessation of hectic fever and to an improvement of the general condition; and further, that nephrectomy done on a contracted sac would be easier and less shocking than at present. These expectations were all fulfilled. July 14, patient was sent home to recuperate. October 25, readmitted in a remarkably improved general condition, having gained over 30 pounds of flesh, with the urine abundant, clear, acid, containing sparse pus-cells. The mass was much shrunken, drainage sinus discharging moderately. October 26, rapid and easy nephrectomy, isolated ligature of vessels. November 6, discharged cured. December 6, presented herself perfectly well.

While it is an error not to remove at any risk and at once an organ, which is the seat of disseminated undrainable mischief, such as multiple miliary or larger foci of septic destruction from whatever cause, it will on the other hand be advisable to establish preliminary drainage, where the kidney has become a simple pus sac, and especially where the patient's general condition is precarious and the removal of the sac presumably difficult on account of its size and possible close adhesions.

In conclusion we may then say that the larger percentage of mortality in secondary nephrectomy—cases of error of diagnosis excepted—is fully explained by the fact, that here we had to deal with inherently grave conditions, both because of a deep deterioration of the general condition, and because prolonged suppuration had led to the formation of extensive, dense adhesions. It has been asserted that the establishment of drainage was the cause of these close adhesions. This assertion, however, has never been proven, nor is it in accordance with established experience. It is far more likely that effective drainage of a closed pus sac will not only stop fever, but will tend to arrest the new formation of adhesions. It may even lead to the decrease of their extent and density.

Examination of the statistical aspect of things from a different stand-point will disclose another interesting fact. While it was seen that the ratio of mortality in primary and secondary nephrectomies stood as 10.34 per cent. to 19.35 per cent., that is about like 10 to 20, the ratio between the combined number of all nephrectomies (primary and secondary) done for suppurating stone kidney, and all nephrectomies (primary and secondary) done for non-calculous pyonephrosis (hemorrhagic infarcts included) was as 20.5 per cent. to 9.7 per cent. Here again we may say roughly speaking, that the mortality following both primary and secondary nephrectomy done for *calculous* disease is more than double that following operations (primary and secondary) for *non-calculous* suppuration. Here also the explanation must be sought for in the fact, that in calculous disease we invariably have to deal with cases of old standing, involving prolonged suffering and loss of strength, while the majority of the non-calculous cases is composed of instances of an acute invasion of short duration, most of the patients having been in good health up to the recent onset. While in the first grouping the proportion is dependent upon both inherent and relative factors, in the latter it is due only to intrinsic conditions, and is absolute.

CASE HISTORIES.

Primary Nephrectomy for Calculous Pyonephrosis.

CASE VII.—*Calculous pyelonephritis of the right side. Cystoscopy. Nephrectomy. Cure.* (Contribution, *loc. cit.*, p. 696.)

E. W. A., age thirty-eight years, merchant, admitted October 13, 1896. Twelve years ago internal urethrotomy for rebellious gleet and stricture. This was followed by acute cystitis, which had persisted ever since that time. Suffered for ten years from periodical attacks of severe renal colic of the right side, accompanied by chills and bloody urination. In spite of ravenous appetite, emaciated to a skeleton. Since ten weeks urine putrid, and from that time on continuous fever, frequent chills, night-sweats, and incessant lumbar pain, radiating toward bladder and right testicle. Urination very frequent. Physical examination: Excessive emaciation and light anæmia of the feet; otherwise normal conditions; an accelerated pulse of good quality. In right loin a large, sensitive, resistant tumor, which descended to the level of the navel and extended to the median line. Urine foul, acid, containing much pus, some blood, and large quantities of detritus; daily quantity about 50 ounces. Temperature 100.2° F. in the morning, with regular evening exacerbation. October 14, cystoscopy. Trigonum moderately congested, especially around the orifice of right ureter, from which a solid plug of pus was seen escaping. From left ureter clear urine. Left kidney could not be palpated. Assumption was fairly justified that this kidney was sound. Operation October 15, 1896. Chloroform; tumor exposed and easily separated from adhesions. Represented a thin-walled sac from which aspirator removed foul pus, and within which a number of stones could be felt. Cortex appeared waxy. Mass ligature and ablation. During the first 24 hours following operation 50 ounces of clear urine voided. From October 18 temperature became normal. Urine continued to be abundant, and patient's general condition, aided by enormous appetite, was rapidly improved, so that on November 15 was discharged cured, having gained 34 pounds in weight.

CASE VIII.—*Renal calculus; pyonephrosis; nephrectomy; cure.* (*Hospital Reports*, 1899, p. 208; 1898, vol. ii, p. 269.)

Blanche W., admitted July 16. Since five months had severe pain in right side of abdomen. Lost flesh and strength. Urine

contained small amount of albumin, pus, no casts. On right side of abdomen a large, hard, painful, movable mass. It could not be positively determined whether it originated from liver or right kidney. Left kidney could not be palpated. July 18: Exploratory cœliotomy at edge of right rectus muscle; mass found to be the kidney. Abdominal incision closed and nephrectomy performed. Kidney separated from surrounding structures with considerable difficulty. Elastic ligature. Gained rapidly in general condition. Discharged August 13, cured.

CASE IX.—*Ascending pyonephrosis. Nephrotomy. Cystoscopy. Nephrectomy. Cure.* (*Hospital Reports,* 1901, p. 338; 1900, vol. ii, p. 562.)

Herman I., clerk, twenty-two years old, contracted a sharp gonorrhœa 16 weeks ago, which about a week after inception extended to bladder, causing painful and frequent micturition. Gradually left loin became painful, and high fever set in with chills and sweats. Urine became loaded with pus. In another hospital left kidney was incised and drained. Since then regained flesh and strength to a certain extent, but renal fistula annoyed him. Admitted September 11, 1900: General condition good, organs of chest and abdomen normal. Both lumbar regions somewhat tender to palpation; left kidney not to be felt, lower pole of right kidney palpable. In left lumbar region a scar, within which a sinus discharging purulent urine. Temperature in morning 100.8°, at night 103.2°. September 12: Gleet present. Considerable quantity of urinous pus escaped from sinus during the night. Methylene blue injected into sinus did not appear in urine voided from bladder. Urine: acid, specific gravity 1009, marked albumin, no sugar, no casts, plenty of pus. September 18, cystoscopy: much pus flowing out of left ureter. September 18: Pain in right loin, radiating to right shoulder. Up to September 26 occasional fever, otherwise condition unchanged. September 27: Nephrectomy. Chloroform. After development and incision of kidney, catheter was passed without difficulty down into bladder. Ureter cut off about two inches below level of iliac crest. Elastic ligature. Removed kidney, a large, thin-walled sac with smooth lining, in which there were a number of areas containing calcareous deposits; no kidney substance recognizable. Course of convalescence uneventful and afebrile, patient passing very large quantities of

urine, varying between 63 and 75 ounces per day. In the beginning urine still contained much pus, but by October 14 this began to diminish. General condition improved rapidly. October 27, ligature came off. October 29, urine clear, acid, 1014, trace of albumin, very few pus-cells, no kidney elements. November 4, discharged cured.

CASE X.—*Calculous pyelonephritis. Nephrectomy. Cure.* (*Hospital Reports,* 1905, p. 170; 1902–1903, vol. iii, page 374.)

Jennie S., age eighteen, admitted December 20, 1902. For five years periodical pain in right loin. Urine cloudy, becoming clearer at rare intervals. During last two weeks fever, chills, frequent micturition, constant pain in right loin, with night sweats and loss of strength and weight. On admission, general condition fair. Temperature 101.6°; pulse 34. Internal organs normal. In right loin a large rounded tumor, which was tender to pressure. Cystoscopy: large amount of pus issuing from right ureter. Urine, acid, 1018, albumin, much pus. December 22, 1902: Nephrectomy. Kidney much enlarged, pelvis distended, containing large, rough, black calculus, and foul pus. Cortex one-half inch thick, whitish in appearance. No tubercle bacilli. Uninterrupted convalescence. January 17, 1903, discharged cured.

CASE XI.—*Calculous pyonephrosis. Nephrectomy. Cure.* (*Hospital Reports,* 1905, p. 171; 1902–1903, vol. iii, p. 390.)

Yetta C., age thirty-five, admitted March 20, 1903. Illness of three months' duration. Acute onset with pain in right loin, radiating down along ureter. Urine turbid. Vomited frequently, had fever and chills, and frequent urination. On admission, general condition fair, internal organs normal. Whole right side of abdomen rigid and tender; in the loin down to the crest of ilium a firm, nodular, tender mass, movable with respiration. Urine: intermittently cloudy, containing traces of albumin, acid, 1031, and pus when cloudy. Diagnosis, calculus pyonephrosis. March 23, 1903: Nephrectomy. Kidney large, cortex thick, pale, and œdematous, with small punctate yellow foci; spreads from these foci showed pus, no bacteria. Pelvis and calices much dilated, containing gray fibrinous clots and a rough, brown stone. Uninterrupted recovery. May 4, 1903, discharged cured.

CASE XII.—*Calculous pyonephrosis. Nephrectomy. Cure.* Typical case of no special interest. (*Hospital Reports,* 1905, p. 174; 1903–1904.)

CASE XIII.—*Calculous Pyonephrosis of right side. Primary nephrectomy. Death.* (*Hospital Record,* 1897, ii, p. 1131, 6.)

Lena W., age twenty-four, miscarriage six years ago. Since nine months, "chills and fever" with attacks of paroxysmal pain in right side. Two weeks ago puncture made below eighth rib posteriorly (in medical ward) yielded pus. Declined incision. Admitted November 19, 1897. Continuous remittent fever, with great emaciation. Right loin occupied by a large tumor, that pushed diaphragm up to sixth interspace and extended downward three fingers below border of ribs. Spleen large and tender. Urine: 1018, much pus, no sugar. Urea 8¼ gr. to the ounce. Pulse weak, 80–92. Diagnosis, Pyonephrosis. Nephrectomy, November 27: Long oblique incision. Fluctuating sac punctured, needle struck stones and withdrew pus. Incision and evacuation of large mass of pus. Packing. Peritoneum reflected and vena cava exposed. Fatty capsule stripped off easily except at upper pole, where there was extensive, dense adhesion to diaphragm. Resection of tenth and eleventh ribs, accidental injury of pleura; suture of pleura. Sharp division of adhesions to diaphragm. Following vena cava, vessels were exposed; ureter and vessels tied and cut. Little hemorrhage; nevertheless deep collapse, lasting until next day. High fever followed, spleen became larger and painful; septic symptoms. Urine remained ample and became clear. Died in coma November 29. *Autopsy:* several *fresh infarcts of spleen and pneumonia* of right lower lobe.

CASE XIV.—*Calculous right pyonephrosis. Nephrectomy. Cure.* (*Hospital Records,* 1908–1909, vii, p. 920.)

Mary M., age thirty-five, housewife, admitted January 27, 1908. Since first confinement, 16 years ago, had urinary difficulty. Two years ago first renal colic. Since two months constant dull pain, no paroxysms, but frequent fever, and loss of 40 pounds in weight. On admission: in right loin large mass reaching two inches below level of umbilicus. Evening temperature 101.8° F. Urine turbid, acid, 1010, loaded with pus. By ureteral catheter: right side urea 0.5 per cent., left side 1.6 per cent. Urine from left side clear. January 30: subcapsular nephrectomy. Elastic mass ligature. As the mass had extended very high up under ribs and toward median line, and as the peritoneum was closely adherent to anterior surface of the mass,

and could not be stripped off without injury, this (the peritoneum) was longitudinally incised, and re-attached by suture, 2½ inches beyond the mesial line of adhesion. Then the mass together with the adherent peritoneum was raised up, and thus the very short vessels of the pedicle became accessible. Ligature came away February 15. Uneventful recovery. Discharged cured, March 19, 1908.

Note.—Good example of treatment of closely adherent peritoneum.

CASE XV.—*Calculous pyonephrosis of right side, exploratory laparotomy; nephrectomy. Cure.* (*Hospital Records,* 1907–1908, vii, p. 944.)

Bertha C., age fifty, Russian, housewife. Admitted September 7, 1908. For two and a half years frequently recurrent attacks of right lumbar pain with fever, chills, vomiting, frequent urination, and night sweats. Had lost much flesh. On admission, in right loin large elongated, soft, and very movable tumor, which was tender. Pulse 110, temperature 101° F. Urine: amber, cloudy, neutral, little albumin, loaded with pus. September 12: Probatory laparotomy. This having dispelled any doubt as to the seat of the tumor, the peritoneal incision was closed; then tumor was exposed by lumbar route. Easy exposure of vessels, separate deligation. Kidney of large size, containing several calculi and much pus, both in pelvis and disseminated through parenchyma. October 1, discharged cured.

CASE XVI.—*Calculous pyonephrosis of right side. Renal calculus of left side. Right nephrectomy. Subsequent left nephrolithotomy. Cure.* (*Hospital Records,* 1907–1908, vii, p. 945.)

Celia R., age twenty-nine, housewife, Russian, admitted, September 18, 1908. Twenty years ago, attack of sharp pain in right loin with vomiting and fever. Seven years ago typhoid, following which had a similar attack, which laid her up for two weeks; urine frequently bloody. Four days ago the last, very violent attack with chill. Urination was never frequent or painful, but urine was very turbid. On admission, temperature 104.2°, pulse 120. In left hypochodridum a large, very tender mass; rigidity of muscles preventing satisfactory palpation. Cystoscopy. Normal bladder. Right ureter, a few drops of thick pus. Left ureter, amber, turbid, loaded with pus, urea 1.4

per cent. Combined urine, amber, acid, 1016, albumin. Radiograph: shadows, denoting calculi in both kidneys. September 19, right nephrectomy. Resection of twelfth rib. Kidney a huge sac containing pus and a large triangular calculus. Rubber ligature, which came off October 10. October 14, left nephrotomy and extraction of oval renal calculus 2½ inches long. Uneventful recovery. Discharged cured, November 18, 1908.

Note.—Remarkable on account of successful attack on both kidneys.

CASE XVII.—*Calculous pyonephrosis of left side. Nephrectomy. Cure.* (*Hospital Records,* 1908–1909, vii, p. 1103.)

Antonia O., age forty-one, seamstress. Russian. Admitted June 24, 1909. November 23, 1905, was operated upon in this hospital for acute osteomyelitis of humerus and suppuration of shoulder-joint. Discharged February 8, 1906. While in hospital had attack of pain in loin. Kidney was palpable and painful. Since last four months had recurrent left lumbar pain, radiating to genitals. Urination never frequent or bloody. Had lost 30 pounds in weight. On admission: temperature 102.6° F.; pulse 100, right kidney not palpable, in left loin tumor of the size of a fist, tender, somewhat movable. Cystoscopy: Trigonum congested. Ureteral orifice easily found. Pressure on left kidney expelled cylinder of pus from left ureter. Right kidney discharging plenty of clear urine. Urine, amber, cloudy, acid, 1016, loaded with pus, no blood. Radiography yielded negative result. June 29, nephrectomy. Evacuation of a number of large renal abscesses by incision to reduce size of tumor. Separate ligation of vessels. Specimen: No parenchyma left. Kidney a system of abscesses; in pelvis a flat stone of large size. Uninterrupted recovery. Discharged cured July 13, 1909.

CASE XVIII.—*Calculous pyonephrosis of right side. Nephrectomy. Cure.* (*Hospital Record,* 1909–1910, vol. x, p. 1453.)

Minnie W., age 15½. United States. Admitted May 26, 1910. Since two years constant pain in right loin, with frequent colicky accentuation. Pain most severe at night. Urination normal. On admission, temperature 99° F., pulse 94. In right loin a large, hard, somewhat nodular and tender mass, extending below umbilical level. Cystoscopy: Cystitis. Catheters passed readily; from right side no secretion whatever; from

left side normal looking urine, amber, clear, acid, containing 2.5 per cent. urea. Radiograph: several calculi. June 4, nephrectomy. Delivery of tumor, vessels separately tied. Specimen: Dimensions of organ, 7½ x 4 x 3 inches; on section, a system of pus sacs, without kidney tissue, with several calculi. Uneventful recovery. Discharged cured, June 18, 1910.

CASE XIX.—*Calculous pyonephrosis of left side. Subcapsular nephrectomy. Cure.* (*Hospital Records,* 1909–1910, x, p. 1455.)

William B., age forty-two, driver, United States. Admitted April 4, 1910. Gonorrhœa 18 years ago. For past seven years had at long intervals attacks of pain in left loin. The last six weeks constant lumbar pain, radiating into left groin. Urination frequent and turbid; had lost ten pounds in weight. On admission temperature 100° F., pulse 84. Kidney-shaped large mass in left loin. Urine, amber, turbid, alkaline, 1020, loaded with pus. Cystoscopy, right side, abundant clear urine; left side, no secretion whatever. Radiograph: several calculi in left kidney. April 7: Difficult subcapsular nephrectomy. Capsule enormously thickened, of cartilaginous consistency and in places one inch thick. In stripping the capsule off the parenchyma, several abscesses were opened. Elastic mass ligature. After cutting away the kidney, a calculus was found to be in the grip of the ligature. Application of another ligature higher up. A large branching calculus was found in pelvis. No parenchyma left. Uneventful recovery. Discharged cured May 22, 1910.

Note.—Remarkable thickness of fibrous capsule.

CASE XX.—*Calculous pyonephrosis of left side. Nephrectomy. Cure.* (*Hospital Records,* 1909–1910, vii, p. 1454.)

Joe G., age fifty, presser, Russian, admitted July 26, 1910. In December, 1908, had exploratory nephrotomy performed at this hospital. Specimen was removed from parenchyma and interstitial glomerular nephritis was found by pathologist. Ever since discharge had dull and constant pain in left loin, frequently augmented to sharp attacks of renal colic, radiating into testes and thigh. Urination frequent and painful. Urine turbid, sometimes bloody. On admission, pulse and temperature normal. Large scar in left loin. Kidney could not be felt. Cystoscopy: both ureteral orifices normal. Clear urine from right side. No

urine from left side. Combined urine: amber, turbid, acid, 1022, full of pus. Radiograph. Calculus in left kidney. August 2, extracapsular nephrectomy. Very difficult isolation on account of dense adhesions and a short pedicle. Elastic ligature applied with much difficulty. Cutting away of mass through parenchyma. Space thus gained, another elastic ligature was applied beyond parenchymatous rests and these were trimmed away. Specimen: a shrunken, degenerated kidney, containing one calculus. Ligature came away on twenty-fourth day. Uneventful recovery. Discharged cured September 11, 1910.

CASE XXI.—*Right pyonephrosis, nephrolithiasis, chronic nephritis of left kidney. Nephrectomy. Death from uræmia.* (*Hospital Records,* 1904–1905, iii, p. 492.)

Annie Sch., age thirty-four, Russian, housewife, four children. Admitted May 18, 1905. Renal colic since fifteen years. Recent development of tumor with fever and emaciation. Very irritable bladder. Cystoscopy: Right ureter furnished no urine whatever, only very thick pus; left, scanty, very pale urine, 1008; urea total 24 hours, 5.4 grammes. No tuberculosis. Heart: mitral insufficiency and stenosis. In right loin large, hard tumor. May 15, typical nephrectomy: separate ligature of vessels. Kidney five inches long, 3½ inches thick, distended with pus, containing branched mulberry stone. No parenchyma left. May 16: somnolence, very scanty urine, finally anuria. May 17, death. Autopsy not obtained.

CASE XXII.—*Primary nephrotomy for non-calculous pyonephrosis, caused by infarct. Suppuration of renal infarct. Nephrectomy. Cure.* (*Hospital Report,* 1903, p. 161.)

Mabel F., age twenty-four; married; nullipara. No history of previous renal trouble. Ten days ago paroxysmal pains in right loin, radiating to bladder. Vomited all ingesta. Was in bed for four days. Day before admission had severe chill and fever. On admission, November 5, 1900, good general condition. Lungs and heart normal. Abdominal parietes of right side rigid. Pressure in right hypochondrium and lumbar region very painful; resistance was felt there, lower border of which extended to umbilicus. Appendicitis and cholecystitis were excluded; presence of the lumbar pain determined us to look for the trouble in the right kidney.

November 7, nephrectomy (chloroform): During induction

of anæsthesia severe epistaxis, necessitating tampon of anterior and posterior nares. Oblique right lumbar incision. Puncture of exposed kidney yielded blood. Near anterior angle of wound peritoneum was sufficiently incised to permit exploration, demonstrating that the abdominal organs were normal; after closure of this incision kidney was delivered. It was of normal size and distinctly lobulated. Occupying the middle lobe, in wedge shape, was seen a discolored pyramidal area of reddish-brown tissue. This being laid open by an incision along the convexity, was found to be interspersed with streaks of yellowish pus. Wedge penetrated entire thickness of the pyramidal and cortical tissue. Vessels isolated and separately secured with silk; ureter was then drawn out and divided at a distance of about four and a half inches from its renal end, and its distal end ligated; gauze drainage of stump; wound closed with button suture. Uneventful recovery. Discharged cured December 5, 1900.

Case XXIII.—*Ectopic sacral kidney the seat of acute inflammation. Nephrectomy. Cure.* (*Hospital Report,* 1903, p. 256; 1902, vol. ii, p. 332.)

Joseph S., age twenty-nine, cloakmaker. Had an attack, similar to the one for which he came to hospital, ten days before. Present illness commenced 24 hours before admission; was marked by severe pain in both lumbar regions, radiating into groins. No chill, but fever; vomited several times. Urination frequent and painful; no hæmaturia.

On admission, October 9, 1902: Fair general condition; lungs, liver and spleen normal. Heart: Disease of aortic and mitral valves. Abdomen: Entire right side rigid, lower half especially so; no free fluid; no tumor felt (on account of muscular rigidity); per rectum, high up above prostate, large, indefinite mass could be palpated. Temperature 103.4°, pulse 104. Immediate operation was thought necessary, as acute empyema of the appendix could not be excluded. Abdomen opened at right side by Kammerer incision. Appendix found free and normal in appearance; it was removed. Exploration revealed mass in the median line, over the lumbosacral junction, covered by peritoneum. In Trendelenburg's position mass was exposed; its peritoneal covering was split longitudinally. The mass was recognized as a kidney; was

firmly lodged at the lumbosacral junction; its vessels came from the aorta in two large branches; was cubical in form, hilus to inner side; the veins ran lengthwise along the hilus; no marked surface depression. While examining the organ a large renal vein was torn. The cortex was so friable that with the most gentle manipulation a deep rent into it was made. The bleeding from these sources was very profuse, and could not be controlled by clamp or tampons. After determining the presence and consistence of remaining kidney by palpation through abdominal wound, nephrectomy was done. Pedicle secured with heavy catgut. Some aberrant arteries at upper pole were ligated. Cigarette drain to stump; layer suture of abdominal wall. Uneventful convalescence. Pathologist's report: Acute degeneration and inflammation of kidney.

CASE XXIV.—*Chronic pyelonephritis and renal atrophy of right side; hemorrhagic infarcts. Nephrectomy. Cure.* (*Hospital Records,* 1906–1907, vii, p. 827.)

Sam K., age twenty-eight, laborer, Russian. Gonorrhœa nine years ago. Five years ago had severe pain in right loin, for which (in another hospital) an exploration was made, when the kidney could not be found and the wound was closed. Pain radiated to genitals, the urination was frequent and bloody, and there was vomiting. Since then frequent similar attacks with chills, fever, and vomiting; urine very turbid. Two weeks ago last attack with hæmaturia. On admission, kidneys could not be felt, severe pressure pain and tenderness in right loin. Temperature and pulse normal. Urine: amber, acid, 1022, pus, a few blood-cells, much oxalate of lime. Cystoscopy: bladder normal. Right ureter and pelvis readily entered by catheter; no secretion whatever. Left ureteral secretion 4 drachms; accidentally lost. December 4, nephrectomy: Oblique incision. Only the lower pole of the kidney could be felt at end of inspiration, high up under the costal border. Resection of eleventh and twelfth ribs. A small, hard and lobulated kidney was delivered with much difficulty. In upper pole a cyst, all over surface of cortex yellow patches of old infarct. As it was a "dead" kidney, it was deligated (elastic ligature) and removed. Pathological report: hemorrhagic infarcts; interstitial nephritis; marked endarteritis. Uneventful recovery. Discharged cured, January 6, 1907.

CASE XXV.—*Pyonephrosis from multiple septic infarcts of right kidney. Nephrectomy. Cure.* (*Hospital Records,* 1908–1909, vii, p. 940.)

Jenny K., age thirty, housewife, Russian, admitted January 25, 1908. In May, 1904, was in gynæcological service, when pyelitis was noted. At that time had a sharp renal colic during pregnancy. Two weeks ago sudden severe pain in right loin with fever and frequent voiding. Four days ago return of pain with increased severity and fever; had two chills and vomited. On admission: Pulse 140, temperature 103.4°, general condition good, much tympany, except in right flank where there was extended dulness. Muscles of right flank and hypochondrium very rigid; pressure caused much pain and resistance, but mass could be felt. Left side of abdomen lax. Ureteral catheterization: Right side, amber, turbid, neutral, albumin, no pus, urea 0.3 per cent.; left side, amber, clear, acid, a few red blood-cells, urea 3 per cent. Radiography: No calculus in any part of urinary tract. January 27, nephrectomy: Kidney fat, very œdematous. High fixation of kidney demanded resection of twelfth rib. Pedicle very short, preventing delivery. Rubber ligature. Kidney much enlarged, congested, numerous small abscesses in cortex, also several hemorrhagic foci which had not yet broken down. February 15, ligature came away. Discharged March 10, 1908. Seen in May entirely cured.

CASE XXVI.—*Nephrolithiasis of right side. Nephrolithotomy. Cure.* (*Hospital Records,* 1908–1909, vii, pp. 1091 and 1110; 1909–1910, x, p. 1407, No. 117, 318.) *Multiple septic infarcts and pyonephrosis of right side. Nephrectomy. Cure. Perireteral abscess. Incision. Cure.*

Samuel Z., age twenty-eight, tailor, Austrian. Admitted November 14, 1908. Since two years frequent attacks of sharp lumbar pain of right side provoked by brisk exercise. Urination five to six times per day; no gravel or blood in urine. During attacks voided no urine, but as soon as he lay down, pain ceased and copious urination began. On admission, good condition. Pulse and temperature normal. Kidneys could not be palpated. Urine: amber, turbid, acid, 1030, red blood-cells. Radiograph showed presence of calculus in pelvis of right kidney. November 10, pyelotomy: extraction of stone from pelvis and nephrotomy for extraction of small stone from a calix. Drainage. December 6, 1908, discharged cured.

Readmitted April 22, 1909. In January, 1909, renal colic of right side. April 25 sharp paroxysmal attack of pain in right side of abdomen. Very frequent urination, vomiting, no hæmaturia. On admission, temperature 106° F., pulse 120. Vague tenderness in right loin and hypochondrium on pressure. Urine: Amber, cloudy, acid, 1012, hyaline and granular casts, pus-cells and a few red blood-cells. Cystoscopy right side: A great number of pus-cells, a few red blood-cells, urea 2 per cent.; left side: Many red blood-cells, hyaline and granular casts, urea 4 per cent. Radiograph negative. April 23, nephrectomy. Kidney deeply and firmly imbedded in cicatricial adhesions. Pedicle too short for delivery, twelfth rib resected to gain exposure. Difficult placing of elastic ligature behind closely adherent kidney, which was extremely friable, demanding careful manipulation. Kidney cut away through parenchyma adjoining pelvis, then all adhering parenchyma was trimmed away from pedicle with scissors. Mikulicz tampon. Specimen: The entire kidney riddled with softening infarcts. May 25, discharged cured.

Readmitted September 1, 1910, when a large periureteral abscess was incised and drained by a section running parallel to and above Poupart's ligament, the peritoneum being stripped up, and the abscess thus entered and drained. October 10, discharged cured.

Case XXVII.—*Pyonephrosis of right side. Nephrectomy. Septic nephritis of left kidney. Death.* (*Hospital Reports,* 1903, p. 165.)

Annie S., age thirty-eight. Ten weeks ago began to feel severe pain in left side, accompanied by flow of bloody vaginal discharge. Curetted at King's County Hospital, Brooklyn; stayed there six weeks. Had lost very much flesh. On admission, September 2, 1909: Emaciated. In right lumbar region a mass the size of a child's head, movable, hard, non-fluctuating, tender, showing balottement. Pulse and temperature normal. Urine: Pale amber, 1006, albumin, loaded with pus, no casts. Urea 1 per cent. Daily quantity 20 ounces. Cystoscopy, turbid urine from both ureters. September 6, nephrectomy: Peritoneal reflection exposed, incised, and other kidney palpated. It was of normal size and consistency. Difficult development of right kidney. Rubber mass ligature; Mikulicz tampon. Duration of operation 40 minutes. Patient did not react well, very restless, temperature 103.6°, pulse 144. Urine 21 ounces in 24 hours,

loaded with pus, granular and hyaline casts. September 10, died.

Autopsy.—Left kidney lobulated, capsule not adherent; marked degeneration, acute congestion; cortex swollen, containing numerous hemorrhages. Peritoneum normal.

CASE XXVIII.—*Pyonephrosis of left side. Nephrectomy. Cure.* (*Hospital Reports,* 1905, p. 172, 1903–1904.

Admitted, June 1, 1904. Since one year suffered with continuous pain in left loin, cloudy urine, and painful micturition. General condition poor. Left kidney enlarged, white blood-cell count 25,800, temperature 101.4° F., pulse 104. Combined urine, acid, 1020, loaded with pus. Cystoscopy: Right ureteral orifice dilated, the left one plugged with pus, a mucous ulcer near it. Urea of combined urine 2.2 per cent. June 4, nephrectomy. Kidney: Double the normal size, very adherent, filled with foul pus. Uninterrupted recovery. Discharged cured, July 14, 1904.

CASE XXIX.—*Pyonephrosis of right side. Perinephric abscess. Empyema of ureter. Incision and drainage of perinephric abscess. Nephrectomy. Ureterectomy. Fecal fistula. Cure.* (*Hospital Reports,* 1905, p. 172; 1903–1904, vol. iii, pp. 376 and 392.)

Morris M., age thirty-eight, admitted July 29, 1903. Present illness began two months ago with severe sticking pains in right loin, chills, fever, sweating, and constipation. On admission: Internal organs normal; no tumor felt in right loin, but complained of marked tenderness and pain there. Urine: acid, cloudy, with mus pus; no tubercle bacilli. Temperature 103.1°; pulse, 130. July 31: Incision of perinephric abscess. Suppuration of abscess cavity diminished, but discharge became distinctly urinous, and pyuria continued unabated. September 10, nephrectomy: Kidney lobulated, enlarged, pale; pelvis and calices much distended by pus; cortex extremely thin. Wound healed normally, but pyuria still continued. October 16: Cystoscopy: thick pus descending from right ureter. Left ureter appeared normal; considerable cystitis. October 19: Ureterectomy for empyema of ureter, which was found to be a thick-walled, elongated sac of the dimensions of a small intestine, filled with thick pus. Extirpation offered great difficulty on account of intimate adhesions to peritoneum and to posterior wall of the ascending colon, demanding constant use of knife. After-treatment com-

plicated by considerable sloughing, as a consequence of which, on October 29, a colic fistula established itself. January 11, 1904, fistula was closed by plastic operation. General condition improved visibly after this, though intense cystitis persisted and remained rebellious to every known form of treatment. February 9, discharged improved (with cloudy urine). April 26, readmitted. Cystoscopy demonstrated intense cystitis. Under the assumption that a stump of right ureter might be the cause of continued trouble, on May 2 posterior surface of bladder exposed by parasacral route. Careful exploration revealed assumption unfounded. June 6, discharged with unabated cystitis.

CASE XXX.—*Metastatic pyonephrosis of right side. Nephrectomy. Cure.* (*Hospital Reports,* 1905, p. 173; 1903–1904, vol. iii, p. 377.)

Julia T., age twenty-two, admitted February 6, 1904. Present illness of one month's duration, characterized by dull pain in right hypochondrium and loin, frequent voiding of cloudy urine, night sweats, fever, and loss of flesh. Before onset, had had paronychia of thumb looked upon as primary focus of infection. On admission, general condition fair, internal organs normal. In right loin an ovoid, smooth, hard, and tender mass. Urine: acid, 1020, trace of albumin, 2.5 per cent. urea, a few hyaline casts, some pus. Cystoscopy: normal bladder, ureteral orifices normal, catheterization of both ureters easy. No urine obtained from right side; that from left kidney was acid, clear, had a trace of albumin and some hyalogranular casts. Cryoscopic index 1.7. February 8, 1904, nephrectomy. Kidney bathed in a perinephric abscess, parenchyma totally disorganized by many abscesses, so that the organ had to be removed piecemeal. March 12, discharged cured.

CASE XXXI.—*Metastatic pyonephrosis. Perinephric abscess. Nephrectomy. Cure.* (*Hospital Reports,* 1905, p. 174.)

Walter B., age twenty-four, admitted July 15, 1903. Six weeks before onset had had small infected wound of toe. Two weeks later began to feel pain in left iliac region radiating toward groin, with chills and fever. Urination not disturbed. July 3, family attendant had incised abscess pointing in rectum. Lost much flesh and strength. On admission, July 15, poorly nourished, internal organs normal. In left loin a large, tender mass. Temperature, 103.2°; pulse, 96. Combined urine, acid, 1018,

trace of albumin, much pus, few red blood-cells; 2.5 per cent. urea. Cystoscopy: normal bladder, except for some injection around left side of trigonum. Both ureteral orifices normal. Right catheter easily introduced; left catheter impeded one-half inch from orifice. Urine: right kidney, acid, faint trace of albumin, 2.0 per cent. of urea. July 18, incision of perinephric abscess. Transient abatement of fever. July 27, severe chill, temperature 104.6°. Frequent repetition of chills with high fever. August 1, nephrectomy. Kidney enlarged, containing two large purulent infarcts, one in lower section, the other in middle of organ. Immediate recession of fever. Uninterrupted recovery. September 21, discharged cured.

CASE XXXII.—*Acute ascending (gonorrhœal?) pyonephrosis. Nephrectomy. Cure.* (*Hospital Reports,* 1905, p. 170; 1902–1903, vol. iv, p. 378.)

Albert R., age twenty-three, admitted April 27, 1903. Had gonorrhœa one and a half years ago. Four months before had attack of grippe. Sudden onset of pain in right loin. Ever since gonorrhœa had very frequent urination, night sweats, and had lost 29 pounds. On admission, general condition poor, internal organs normal, in right loin a movable, tender, rounded mass of uneven surface. Urine: acid, 1028, albumin, pus abundant. Cystoscopy: bladder normal, both ureteral orifices congested, clear urine descending from left ureter, masses of pus from the right one. Catheter passed easily into left ureter, but was arrested in right ureter one-half inch from bladder. Deep urethral stricture of large calibre. Left kidney discharged acid, albuminous urine, with one and a half per cent. of urea, pus-cells and a few red blood-cells. Right kidney yielded only pus. May 1, 1903, nephrectomy. Kidney very large, lobulated, everywhere adherent. Its structure entirely disintegrated by numerous abscesses. Pelvis much dilated by pus. Ureter thickened, œdematous, its lumen narrowed, mucous lining hyperplastic and ulcerated. Uninterrupted recovery. May 31, discharged cured.

CASE XXXIII.—*Pyonephrosis of right kidney. Perinephritic abscess. Incision and drainage. Nephrectomy. Cure.* (*Hospital Records,* 1908–1909, vii, p. 941.)

Joseph L., age ten years, school boy. Admitted August 31, 1908. Four weeks ago sharp pain in right loin, non-radiating, no frequency of urination. Since a week fever and chills. On

admission in right loin a mass, extending to level of umbilicus and to mammary line. Deep fluctuation at lumbar aspect; muscles there rigid; much tenderness. Urine clear, acid, 1030, few epithelial and pus-cells. White blood count 26,600, polynuclears 32 per cent.; temperature 102.6°, pulse 108. September 1: incision and drainage of lumbar abscess, followed by profuse suppuration, remittent fever, and a moderate diminution of lumbar mass. September 16, cystoscopy with small, special instrument anæsthesia and after meatotomy. Bladder normal. Catheterization of both ureters easy, but flow of urine so scanty that no advantage was thus gained. September 29, nephrectomy. Elastic ligature. Kidney permeated by a large number of smaller and larger abscesses. Pus, *Staphylococcus aureus*. Immediate drop in fever. Uneventful recovery. Discharged cured, October 22, 1908.

Case XXXIV.—*Laparotomy for supposed ureteral calculus of right side. Explorative extraperitoneal ureterotomy (no stone found). Suppuration of wound. Second futile exploration of ureter. Pyonephrosis. Nephrectomy. Cure.* (*Hospital Records*, 1908–1909, vii, p. 1100.)

Jacob S., age thirty-nine years, tailor, Russian. Admitted December 2, 1908. On April 27, 1907, had entered medical service. Diagnosis chronic appendicitis. Operated upon July 9, 1907. Discharged cured. Readmitted, November 9, 1908. Was well until nine weeks ago, when felt sharp, paroxysmal attacks of pain in right loin radiating into groin and right testis, brought on by violent locomotion, when urine became bloody. Skiagraph showed a small round shadow half an inch from orifice of right ureter. Laparotomy through right rectus to explore course of ureter. No stone could be palpated; closure of wound. November 14, discharged with hope, that very small stone may be voided. Readmitted December 2, 1908. Continued sharp pain in right loin radiating to penis. Painful and frequent urination. Pulse and temperature normal, kidneys non-palpable; deep pressure in right flank and along right ureter painful. Urine, amber, clear, 1030, no blood or pus. December 5, extraperitoneal ureterotomy with negative result. Ureteral catheter passed without impediment to pelvis and bladder. Closure of ureter and of external wound. Suppuration of wound followed and ureteral fistula resulted after incision and drainage on January 2, 1909.

March 10, second futile retroperitoneal exploration. Persistence of ureteral fistula. March 27, high fever set in with acute persistent lumbar pain. March 29, nephrectomy. On section of ureter pus was seen escaping from lower segment. Separate ligation of vessels. Specimen: kidney enlarged; calices and pelvis congested and studded with hemorrhagic areas. Near upper pole several abscesses were found in cortex. May 16, discharged cured with normal urination.

Causes of death in 29 primary nephrectomies for calculous and non-calculous pyonephrosis: (1) septic pneumonia; (2) anuria; (3) septic, acute nephritis of opposite kidney.

SECONDARY NEPHRECTOMY FOR CALCULOUS PYONEPHROSIS.

CASE XXXV.—*Calculous pyonephrosis. Nephrotomy* and *evacuation of five renal abscesses, each containing a stone. Closure of the wound. Recurrence. Nephrectomy of the calculous kidney. Cure.* (Contribution *loc. cit.*, p. 695.)

Mrs. J. V., age forty, multipara, admitted June 8, 1896; had suffered from persistent hæmaturia five years ago, which ceased spontaneously. A year ago had sharp renal colic, accompanied by fever and vomiting. Shortly after this pus in the urine. Micturition never painful. Since four months continuous pyuria and noticeable emaciation. On admission: large, dense, non-fluctuating tumor in right loin, which protruded into hypochondrium, displacing the colon downward and forward. Urine abundant, acid, 1016, contained large quantities of pus. June 10, cystoscopy. Pale vesical mucous membrane. On gentle massage of the right groin a cylindrical plug of pus escaped from the right ureter, the orifice of which was much congested. Left ureter normal. Into this catheter introduced by Kelly's procedure. Sixteen grammes of urine collected, that contained a few pus-corpuscles and traces of albumin. Hence it was concluded that the left kidney, though not perfectly sound, was not seriously involved.

June 15, right kidney exposed and freely incised. From pelvis and four calices large quantities of pus and several irregular shaped uratic stones removed. Kidney drained. Little reaction. Secretion diminished rapidly, and patient was discharged July 18 with nearly closed wound. General condition had improved

noticeably. October 7, presented herself again, reporting that the wound, which had been closed for several weeks, had reopened a week ago, discharging a large quantity of pus. Lumbar tumor smaller than it was before the first operation, painless to touch; general condition very good, urine acid and abundant, containing much pus. October 22, 1896, nephrectomy. Kidney contained six abscesses, each harboring a stone. Renal parenchyma waxy, very much shrunken. By October 27 urine became nearly normal, though still containing microscopical quantities of pus. November 20, mass ligature of the pedicle came away. December 15, discharged cured.

CASE XXXVI.—*Calculous pyonephrosis of right side; two subsequent nephrotomies with evacuation of pus and stones (at another hospital); nephrectomy. Cure.* Uncomplicated case. (*Hospital Reports,* 1901, p. 199.)

CASE XXXVII.—*Dystopia renalis with nephrolithiasis. Exploratory laparonephrotomy. Transperitoneal nephrectomy. Death.* (*Hospital Reports,* 1901, p. 330, 1900, vol. i, p. 714.)

Philipp E., tailor, twenty-two years old, had been suffering for four years from many attacks of severe pain seated in the right side of the hypogastrium, extending into the right iliac fossa, lasting about 24 hours, during which he vomited. The last attack, accompanied by repeated vomitus, began 24 hours before admission. Micturition frequent, not painful. On admission, April 19, 1900: Moderately well-nourished body, thoracic organs normal; the abdominal organs apparently normal, except that there could be felt just below the umbilicus and slightly to its right side a fusiform, hard and tender, non-movable body, the lower portions of which could not, during bimanual rectal palpation, be brought within the grasp of the fingers. Kidneys could not be palpated. Mass not influenced by respiration. Urine clear, acid, 1030, trace of albumin, pus-cells, red blood-cells, bladder epithelia, and mucus. Temperature 100.8°. April 23, cystoscopy. Trabeculated but otherwise normal bladder, normal ureteral apertures. With these data a satisfactory diagnosis of the tumor was not possible. The symptoms pointed to nephritis, but the presence of a patent urachus, in open communication with the bladder, was also thought of, though no signs of such an aperture could be found by cystoscope. Fever and intense paroxysmal pain in tumor determined exploration. April 23,

median incision below umbilicus. Tumor retroperitoneal, closely and immovably adherent to promontory. Peritoneum over tumor incised and stripped off for a distance; profuse hemorrhage. Wedge-shaped piece cut out for microscopical examination. Hemorrhage controlled by parenchymatous suture, the peritoneum closed over mass. Incision of the abdominal wall united. Slight rise of temperature (101.4°). Some vomiting. Wounds healed by first intention. Blood appeared in the urine and made probable that the tumor was a kidney. This was confirmed by pathologist, who reported specimen to be renal tissue in state of chronic interstitial nephritis. Patient declining further operative procedures, was discharged May 17. June 19, readmitted, stating that he had had three severe attacks of pain and vomiting together with fever, each attack lasting several days. Temperature 102.6°, pulse 116, respirations 26. Marked prostration, exquisite tenderness with much increased size of mass. June 19, temperature 105°, pulse 130, urine loaded with pus, pain increasing.

Nephrectomy at 8.30 P.M.; chloroform. Abdomen opened through scar of previous incision, intestines packed away. Retroperitoneal tumor representing kidney isolated. It lay across front of vertebræ, reaching upward to upper border of fourth lumbar vertebra, downward into middle of sacral concavity. Laterally further over to right side than to left. Peritoneum divided and tumor exposed. Left margin convex, right margin concave with pelvis adjoining, in which a stone was felt. This was extracted through an incision. Presence of second kidney ascertained by palpation. Ureter lay in front, vessels behind kidney, tightly held between them. Rubber mass ligatures. Edges of posterior peritoneal incision sutured to those of anterior parietal peritoneal wound. Abdominal parietes closed except at angle, where drainage was provided for. Specimen: organ of shape of truncated cone 10.5 cm. wide at base, 10 cm. high. Both anterior and posterior surfaces crossed each by furrow 4 mm. deep (bed of vessels and ureter). On anterior aspect necrotic area. In cavity of pelvis pus and a stone of good size. Pyelonephritis, surgical kidney. Passed 11 ounces of urine five hours after operation, 1040, acid, pus, hyaline and granular casts, albumin. Temperature fell to 101.4° F. Urine during first 24 hours 37 ounces. Hiccoughs, vomiting, failing pulse. June 23,

failing, urine 38 ounces, loaded with pus, continued vomiting, icterus, facies hippocratica, temperature 103.2° F., died.

Wound Examination Post Mortem.—Peritoneal sutures intact and united, general peritoneal cavity perfectly walled off, no peritonitis. Left kidney, much congested and enlarged. Acute degeneration and interstitial hemorrhages on a chronic nephritis.

Epicrisis.—It was a mistake not to remove the kidney at the first operation. It might have saved the patient.

CASE XXXVIII.—*Calculous pyonephrosis of left kidney. Perinephritic fecal abscess. Incision and drainage. Nephrectomy. Fecal fistula. Chronic sepsis. Death.* (*Hospital Reports,* 1901, p. 339; 1900, vol. i, p. 853.)

Rosie B., housewife, thirty-seven years old, multipara. Five weeks ago felt pains in right, later on in left loin, this latter pain remaining until now, relieved by flexion of the left thigh. Pain is of varying intensity, constant. Vomits easily, is constipated. Urine scanty, becoming extremely so during exacerbations of pain. Lost considerable flesh. Admitted February 13, 1900: General condition poor, emaciated, anæmic, tongue coated; bronchial catarrh. Heart, liver, spleen normal. Abdomen tympanitic. In left lumbar region a large, tender, palpable and visible tumor, abdominal wall rigid. Pelvic organs negative; legs œdematous. Pulse 112, respirations 28, temperature 102.4°, rising to 103.4° in the evening. Urine loaded with pus. February 15: Lumbar incision evacuated a large quantity of foul pus from a retroperitoneal cavity extending well down into the iliac fossa. Drainage. Fever moderate after this, never absent; pus remained offensive, often fecal in odor and character. Blood appeared in urine, but soon disappeared from it; the urine continued to contain pus, albumin, daily quantity about 35 ounces. February 22: Chill, with temperature 105.4°; catarrhal pneumonia in lower lobe of lung of the right side. By March 6 this had abated, but cavity was still discharging large quantities of foul, feculent pus; urine continued purulent. Patient evidently suffering from septic condition, due to a disorganized kidney, complicated by colic fistula. As salvation was only possible by removal of kidney and the conversion of irregular and labyrinthine wound into a simple cavity, March 9, nephrectomy.

Chloroform. Oblique incision. An hour-glass-shaped cavity was found, its narrow neck corresponding to a defect in lumbar fascia, which also was freely divided. In upper angle of interior cavity there was an irregular, closely adherent, and extremely dense cicatricial mass (identified as the kidney), containing here and there rudiments of renal tissue. From the centre of this mass a renal calculus of the size and shape of a pigeon's egg was extracted, together with a large quantity of chalky, soft material. To reach the upper limits of this mass, portions of the twelfth and eleventh ribs had to be resected. Intracapsular enucleation of kidney impossible on account of cicatricial deposit of incredible density. Sharp dissection by scalpel and scissors. Previous to this the peritoneal reflection was well exposed, likewise that of the pleura, and by great care injury to both was avoided. As soon as a practicable pedicle had been formed, this was secured by an elastic ligature and the mass was cut off. Communication with intestine not found. Cavity packed, anterior angle of large wound closed by a few button sutures passed through all layers of abdominal wall. Toward end of this severe operation saline infusion of 1000 grammes was made. March 10: Patient rallied well, temperature dropped to 98.6°. Dressings soaked by an enormous quantity of extremely fetid, turbid, feculent material. Urine: First specimen after operation 3 ounces, yellowish-brown and extremely fetid, containing blood and pus, granular casts, and very much albumin. March 25: Ligature came away; though there was no fever, patient visibly growing weaker, urine containing much albumin, red blood-cells, and pus; aversion to every kind of nourishment, is septic. March 29: Temperature 99°. During April wound continued to discharge fæces and pus, and showed no tendency to contract. Alternations of severe rigor and high fever, with normal and subnormal temperatures, the development of bed-sores, an increasing aversion to food, and deepening emaciation, finally led to patient's total exhaustion, which caused her death on May 6.

Autopsy (May 6, 1900).—Incision in left lumbar region just below free border, leading to a cavity, relations of which were difficult correctly to ascertain because of adhesions and extensive inflammatory products present. Attached to upper edge of incision a coil of intestine, which is the descending colon, showing a large defect from which fæces were escaping.

CASE XXXIX. — *Calculous pyonephrosis. Nephrotomy. Nephrectomy. Uræmia. Death.* (*Hospital Reports*, 1901, p. 341; 1900, vol. ii, p. 186.)

Sarah A., housewife, forty-five years old. For five years frequent, painful urination. Two months ago noticed large tumor in right loin and hypochondrium. Loss of flesh. On admission, June 20, 1900: Emaciated, temperature 101°; organs of chest and abdomen normal, except that there was in right loin a large, nodular tumor extending down to within two inches of Poupart's ligament, tender to touch, scarcely movable, and little influenced by respiration. June 20: Inflated colon lying in front and to inner side of tumor. June 22, cystoscopy: Bladder of normal appearance, pus escaping from right ureteral orifice. Urine: alkaline, containing large quantity of muco-pus, no casts, no tubercle bacilli. June 25, nephrotomy. Ether. Tumor incised, large quantity of pus evacuated. Tumor still remaining very large, two more abscesses opened through first incision under guidance of finger. Large calculus extracted from pelvis. Edges of pus sac sutured to skin, extrarenal spaces packed with gauze, two drainage tubes inserted in renal pelvis, wound dressed. Toward end of operation pulse became imperceptible; a saline intravenous infusion. June 27: Rallied slowly, passing large quantities of clear, acid urine. Moderate fever, pulse still very rapid. Very profuse discharge, requiring frequent change of dressings. June 28: Urine turbid, containing pus, no casts; general condition improved. July 1: Urine 25 ounces, very turbid, alkaline, containing pus, triple phosphates, many bacteria. Discharge from incised sac and from the rest of wound continued excessively copious, and, though fever was moderate, patient was failing. Only hope lay in getting rid of the ill-drained pus sac. August 3, nephrectomy. Chloroform. Massive tumor exposed. A number of good-sized calculi felt in the degenerated organ, which, on account of considerable dense adhesions, was developed with much difficulty. Bleeding moderate. Elastic mass ligature. Wound packed with gauze, its angle closed by button sutures. Patient bore operation very badly. Immediately after its completion temperature began to rise, reaching 104° by midnight. Excessive restlessness. August 4: No response to ordinary forms of stimulation; intravenous saline infusion. Vomited black material. Passed only 13 ounces of a very thick and turbid

urine since operation. Temperature 105.6°. Died at midnight. No autopsy.

Epicrisis.—It was an error not to have primarily removed the kidney.

CASE XL.—*Calculous pyonephrosis. Nephrotomy. Nephrectomy. Cure.* (*Hospital Reports,* 1903, p. 159.)

Sarah L., twenty-eight years old. Admitted October 17, 1900. Multipara. Three years ago had attack of renal colic with radiating pain to genitals and thigh; tenesmus; attack terminated with passage of two small stones. From that time on constant pain in right loin. No blood in urine, which was constantly turbid. Four weeks ago an unusually sharp attack accompanied by nausea, lasting a week. Had lost much flesh and strength. On admission: Normal internal organs; pulse and temperature normal. In right loin a large, tender tumor, its outlines readily seen, extending to median line, and downward to level of umbilicus; smooth, movable. October 8, cystoscopy. Moderately congested bladder, pus escaping from right ureter. Urine cloudy, acid, sediment consisting of pus, epithelial cells, and mucus; daily amount, 15 ounces; no casts; no tubercle bacilli. October 22, temperature rose to 101°. Passed 18 ounces of urine. Patient's general condition poor, strengthening regimen. November 16, nephrotomy. Oblique incision. Scanty layer of fat. Kidney exposed and delivered, was fluctuating. Incision along convex border evacuated large quantity of foul pus. Large stone crumbled away in the grip of forceps. By irrigation débris removed from pelvis of kidney. Hemorrhage considerable, patient's condition alarming. Kidney drained and replaced. Patient rallied from operation, quantity of urine increased, but had fever every evening. Pus continued in urine. December 21, subcapsular nephrectomy. Previous to operation preliminary intravenous infusion of 1000 cm. of saline solution. Chloroform. Kidney closely adherent to peritoneum, which was accidentally opened, but immediately closed by suture. A second peritoneal tear in delivering upper pole of kidney, which could not be closed by suture, protected by packing. Fibrous capsule of kidney intimately adherent to surrounding tissues. It was split along

convexity and parenchymatous portion readily enucleated. Elastic ligature. Wound packed with iodoform gauze brought out at upper angle; lower angle closed by button sutures. Specimen: Somewhat shrunken kidney, 4 x 2 x 1 inch; cortex and pyramids atrophic, yellow. Patient bore operation fairly well. December 26, temperature normal. General condition much improved. January 13, 1901, ligature came away. February 17, discharged cured, in very good condition. Urine free from pus.

CASE XLI.—*Calculous pyonephrosis. Insufficiency of opposite kidney. Nephrotomy. Improvement of insufficiency. Nephrectomy. Cure.* (*Hospital Reports,* 1905, p. 173.)

Abraham L., age sixty-one, admitted October 15, 1903. Illness of three months' standing. Great frequency and pain in voiding cloudy urine. General condition very poor, fever to 103°, arteriosclerosis, emphysema of lungs, liver large, heart dilated. In left loin large tender, mass. Cystoscopy: Severe cystitis, preventing view of ureters. Urine: acid, 1010, albumin, pus. Urea 1.9 per cent. Total for 24 hours 138 grains. October 26, nephrotomy, removal of many calculi and evacuation of foul pus. Immediate improvement, quantity of excreted urea rising by November 18, to 438 grains, quantity of urine having doubled. Temperature which had fallen after operation rose again on November 29. December 4, nephrectomy. Specimen: parenchyma almost gone, still a number of stones in pelvis and calices. Cessation of fever, uninterrupted recovery. Discharged cured. January 18, 1904, urine still containing albumin and hyaline casts, but showing 411 grains of urea.

Note.—Was readmitted four months later in uræmic coma, to which he succumbed within two hours after admission. This case is accounted for in these statistics among those who died, though the operation has surely had nothing to do with the lethal ending.

CASE XLII.—*Calculous pyonephrosis of right side. Nephrotomy. Nephrectomy. Cure.* (*Hospital Records,* 99, ii, p. 631.)

Gertrude K., age forty, housewife. Admitted February 20, 1899. Seven months ago, first attack of renal colic. Nephrotomy done at Hartford, Connecticut, when stone was removed with much pus. Was operated on twice more, when more stones were extracted. On admission, a sinus was found leading down to a large tumor situated in right loin, which extended down-

ward to level of umbilicus. Left kidney not palpable. Urine, 42 ounces, acid, 1010, albumin, pus, urea 3 to 5 grains. Evening temperature about 102°, no night sweats. February 24, nephrectomy. Very difficult dissection on account of close adhesions of capsule to peritoneum and diaphragm. Pedicle tied outside of capsule by two elastic ligatures. Uneventful recovery. Ligature came away on twenty-second day. April 18, discharged cured.

CASE XLIII.—*Calculous pyonephrosis on right side. Nephrotomy extraction of stone impossible on account of hemorrhage. Nephrectomy. Cure.* (*Hospital Records,* 1898, i, p. 551; ii, p. 260.)

Pauline B., age twenty-five years, seamstress, Russian. Large painful tumor of right lumbar region, urine loaded with pus, fever. December 28, nephrotomy. Evacuation of pus (collapse), drainage. February 22, 1898, repeated efforts at extraction of stone abandoned on account of hemorrhage. April 23, discharged at request. Readmitted July 4. Sinus as before. July 11, nephrectomy. Difficult and bloody dissection. Elastic ligature. Saline infusion prevented collapse. August 11, discharged cured.

CASE XLIV.—*Calculous pyonephrosis of left side. Nephrotomy. Nephrectomy. Cure.* (*Hospital Records,* 1898, ii, p. 81; ii, p. 749.)

Amelia Z., age twenty-eight, multipara. Admitted July 1, 1898. Had a vesical catarrh since three years, not improved by irrigations. December 27, 1897, paroxysmal attack of renal colic with high fever, urine purulent and very fetid, acute pain in left loin; appearance of large tumor. July 2, nephrotomy, evacuation of 800 Gm. of fetid pus and of a large, branching stone; drainage. July 14: Temperature normal, discharge formerly purulent, now serous (urine); tumor much reduced in size. Discharged with directions to return. October 23, readmitted. General health excellent. Discharge again purulent, temperature 98.6° F., left kidney still very palpable. Urine abundant, contains adequate urea and much pus. October 25, nephrectomy. Uneventful recovery. November 6, urine absolutely normal (no pus). Discharged cured.

CASE XLV.—*Calculous pyelonephritis of right side. Nephrotomy. Second nephrotomy and removal of pelvic calculus (both operations done at Birmingham, Ala.). Nephrectomy of con-*

tracted kidney. Cure. (*Hospital Records,* 1906–1907, vii, p. 848.)

Samuel M., age thirty-four, Russian, storekeeper. Admitted November 27, 1906. Five and a half years ago, severe pain in right loin, with vomiting, attacks recurring frequently. No radiation to bladder or testes. Six months later the appendix was removed at Birmingham. Two months afterward return of attacks. Three years ago nephrotomy, evacuating pus from kidney. Wound healed within two months. Renal colic continued in frequent attacks, hence six months after last operation renewed nephrotomy, when an irregular stone was removed from pelvis of kidney. Wound healed in four weeks. Since then recurrence of painful attacks with vomiting. Urine always cloudy. On admission, pulse and temperature normal. Emaciated, with suffering expression. In right loin oblique scar. No tumor felt, but deep pressure very painful. Cystoscopy: Mucosa swollen. Catheters entered both ureters easily. Urine of both sides loaded with pus, that of right side containing blood. Urea scanty in both urines. Evidently both kidneys were unsound. December 5, typical nephrectomy; on account of necessary haste, elastic ligature of pedicle. Kidney very small, irregularly contracted, deeply congested, contractions corresponding to massive cicatricial bands. Calices and pelvis dilated, cortex very thin. January 1, ligature came away. January 5, discharged cured.

Note.—Patient died of uræmia in January, 1911.

Case XLVI.—*Calculous pyonephrosis of right side. Nephrotomy. Subcapsular nephrectomy. Cure.* (*Hospital Records,* 1908–1909, vol. vii, p. 1105.)

Lizzie K., age forty years, housewife, Russian, multipara. Admitted May 4, 1909. Five months ago dull aching pain began in right loin and had been constant. Lost weight. No hæmaturia or frequency of voiding. On admission, poorly nourished, temperature 100° F., pulse 136. In right flank a large, smooth, ovoid and tender mass, which is very movable. Urine, amber, clear, acid, 1018, a few pus-cells and coarse granular casts. Urea 1.7 per cent. Cystoscopy: Mucosa pale, trabeculated. Both ureters easily catheterized. Left kidney: Abundant clear urine. Right kidney: Absence of all secretion. Radiography, large irregular shadow in right loin. May 8, nephrotomy. Twelve ounces of thick pus evacuated. Drainage. Profuse dis-

charge continuous. May 31, temperature 104° F., remaining high until June 5, when nephrectomy was done. The organ was still very large. Capsule opened, kidney stripped, and large undrained abscess evacuated. A branching stone came away with pus. Easy delivery, elastic ligature. Specimen: No parenchyma; calyces distended by calcareous débris and pus. Uneventful recovery. Ligature came away on twenty-third day. Discharged cured July 7, 1909.

CASE XLVII.—*Ureteral calculi. Retroperitoneal exposure of right ureter. Nephrotomy. Passing of several stones. Acute hemorrhagic pyonephrosis. Nephrectomy. Secondary ureterectomy on ureter containing stone. Cure.* (*Hospital Records*, 1907–1908, vii, p. 906.)

Jennie F., age nineteen years, Russian, belt-maker. Admitted February 11, 1908. Since three months frequent renal colic of right side with vomiting and urgency of urination; between attacks constant dull pain in right loin, radiating to right thigh. On admission, kidneys not palpable, right rectus tense. Pulse and temperature normal. Urine, amber, acid, 1012, trace of albumin, no pus or blood. February 12: Radiograph shows shadow in right ureter 2½ inches above vesical inosculation. February 18, cystoscopy. Bladder and ureteral orifices normal, catheters passed easily into pelves. Immediate rise of temperature (with chill) to 105°, urine containing blood and pus. Pain in right loin much increased. February 20, retroperitoneal exposure of right ureter by iliac incision. Ureter much dilated and thickened, but no stone could be felt. Exposure of right kidney by lumbar incision and delivery of organ. Nephrotomy and exploration of pelvis yielded also negative result. Drainage of pelvis, closure of both wounds. Fever continued with the old pain. February 23, passed *per urethram* about 10 fragments of crushed stone. Fall of temperature and diminution of pain. Did well until March 14, when there was a sudden rise of temperature to 106° with chill and sharp pain in right loin. Evidently an infection of the kidney had taken place, wherefore on March 15, nephrectomy was done. Kidney was found much enlarged, congested, and was the seat of a large number of hemorrhagic foci in various stages of purulent disintegration. Pelvis strongly congested. As radiograph still indicated the presence of a shadow in the lower ureter, the stump

of this organ was stitched to the skin and drained. Neither a ureteral catheter nor a metal instrument, nor palpation could reveal the presence of a stone. Elastic ligature came away on the twenty-fifth day, and the wound closed rapidly except where a tube passed into ureter. Further steps for the removal of the calculus were declined and she was discharged on April 17, 1908.

Readmitted February 14, 1909. After her discharge in April, she continued to suffer from attacks of pain along the ureter, and her urination remained frequent and painful. General condition was much improved. Wound in right loin had closed. Skiagraphy still positive. February 24, ureterectomy by long lumbo-inguinal incision. Organ much congested and dilated; in its lower end a very movable calculus of the shape and size of a date kernel. Interrupted recovery. Discharged cured, March 23.

SECONDARY NEPHRECTOMY FOR NON-CALCULOUS PYONEPHROSIS.

CASE XLVIII.—*Pyonephrosis of left side of old standing. Nephrotomy. Nephrectomy. Cure.* (*Hospital Reports,* 1899, p. 212.)

Jenny L., age twenty, admitted March 8, 1898. Never had been ill before. Eleven days ago began to have severe pain in left loin with chills and fever. In left loin hard, painful, rounded and movable mass, extending to level of umbilicus. Urine acid, 1023, albumin, no sugar, loaded with pus, 34 ounces in 24 hours. Temperature 103° F., pulse 100. March 14, nephrotomy. Kidney a pus sac, devoid of parenchyma. Drainage. Urine passed by urethra became clear and healthy. March 28: Tumor scarcely palpable. Easy nephrectomy, individual ligatures. Rapid recovery. Discharged cured June 27, 1898.

CASE XLIX.—*Large pyonephrotic kidney. Nephrectomy. Cure.* (*Hospital Reports,* 1899, p. 213.)

Tillie L., age thirty-five, admitted October 27, 1898. October 31, nephrotomy. Improvement of general condition. December 4, sent home to recuperate further. January, 1899, readmitted. Nephrectomy. Uneventful recovery.

CASE L.—*Ascending gonorrhœal pyonephrosis, perinephritic abscess. Nephrotomy. Drainage. Nephrectomy. Cure.* (*Hospital Reports,* 1899, pp. 213 and 214.) Typical case of no special interest.

CASE LI.—*Ascending gonorrhœal pyonephrosis. Nephrotomy. Improvement of general condition. Nephrectomy. Cure.* (*Hospital Reports,* 1901, p. 338.) Typical case without special interest.

CASE LII.—*Old pyonephrosis of left side. Acute suppression of urine of right kidney. Anuria. Double nephrotomy. Late secondary nephrectomy. Cure.* (*Hospital Reports,* 1903, p. 166.)

Clara S., age twenty-one, married, unipara. Six months ago began to have fever, which was declared to be malaria. Pregnant in third month. Three days ago developed severe pain in left loin; the following morning had severe chill with fever, a second chill the following night. During this last chill felt acute pain in right loin also. Frequent vomiting, great prostration. Had passed no urine since three days. Catheterization brought forth one ounce of thick pus only. On admission, March 5, 1901, pale, emaciated, anxious expression, exhaling urinous odor. Uterus the size of a fist. In left loin a large, painful mass. Pressure in right costovertebral angle also painful. Dry pleural friction sounds at both bases. Bladder empty. Immediate double nephrotomy and drainage. Left kidney exposed, was found distended by two pints of turbid urine. Incision and drainage. Right kidney was found contracted. Free incision opened a number of abscesses. Drainage. Chloroform anæsthesia, duration of operation one hour. March 6, aborted, curettage, intravenous infusion. Copious urinous discharge from both lumbar wounds. Temperature normal. March 11, return of fever. March 18, on account of continued fever nephrectomy of right side. Elastic ligature. Only traces of parenchyma left in specimen. March 19, passed 3 ounces of urine by urethra, then 5 ounces. April 7, ligature came off. Passed normally 39 ounces of urine. April 14, drainage withdrawn from left kidney. May 8, discharged cured, in excellent condition.

Note.—A desperate case, in which timely action was well rewarded.

CASE LIII.—*Nephrotomy done for pyonephrosis in another hospital. Far gone sepsis. Nephrectomy. Uræmia. Death.* (*Hospital Reports,* 1905, p. 174.)

John M., age forty-six. Admitted June 27, 1904. Five years ago an operation was done elsewhere, since when patient had been wearing a drainage tube. Frequent formation of abscesses

followed, which were either incised or had opened spontaneously. Extremely bad general condition. Urine acid, scanty, loaded with pus, 1010. July 1, nephrectomy. Kidney degenerated, a number of abscesses in cortex. Total quantity of urine passed from July 1, to July 4, 12 ounces, ending in total suppression and uræmia. Died July 4, in coma. No autopsy was permitted.

CASE LIV.—*Pyonephrosis of left side. Nephrotomy. Nephrectomy. Cure.* (*Hospital Records,* 1898, ii, p. 198.)

Jennie L., age twenty, cap-maker, Russian. Admitted March 9, 1898. February 27, sudden pain in left side with chill, followed by frequent recurrence of pain, fever, and chills. Spleen enlarged, palpable; behind it another globular, movable, and painful mass, reaching down to level of umbilicus, not influenced by respiration. Pulse 130, respiration 36, temperature 103.4° F. Urine 1023, traces of albumin, no sugar, much pus and some blood. March 4, nephrotomy. One quart of fetid pus evacuated, no stone found; drainage. Immediate fall of temperature to 99°–101°. Profuse discharge from tubes. Patient's condition much improved. By June 28, tumor had so diminished that it could not be palpated; discharge still profuse. Very easy nephrectomy of a small, shrunken, cicatricial mass. Separate ligatures of vessels. Discharged cured July 27, 1898.

CASE LV.—*Ascending pyonephrosis of right side* (*old gonorrhœa; cystitis; strictures*). *Nephrotomy. Subcapsular nephrectomy. Cure.* (*Hospital Records,* 1898, i, p. 518.)

William B., age thirty, clerk. History of gonorrhœa, urethritis, stricture, and intense cystitis. Internal urethrotomy did not improve cystitis. Since two weeks intense pain in right side with frequent chills and high fever. Pain radiating to right testis. Large tumor in right hypochondrium. November 27, 1897, incision and drainage of large quantity of pus. Immediate fall of temperature to 99°, remaining at this level. Discharge diminishing *pari passu* with healing of wound and general condition improving steadily. December 24, cystoscopy. On massage pus expelled from right ureter. Urine becoming more purulent. Tumor still reaching two inches below costal border. Gained 15 pounds in weight. January 4, 1898, nephrectomy. Stripping kidney out of fibrous capsule; elastic ligature. Urine abundant. Interruption of healing by fever and retention after removal of packings. January 11, several abscesses opened. February 8, rubber came away. April 16, discharged cured.

CASE LVI.—*Fistula following nephrotomy. Nephrectomy. Cure.* (*Hospital Reports,* 1901, p. 197.)

Tillie L., age thirty-five. Admitted December 31, 1898, with renal fistula. January 3, 1899, nephrectomy. Kidney disorganized only traces of parenchyma remaining. Separate ligature of vessels. Discharged cured February 5, 1899.

CASE LVII.—*Ascending pyonephrosis of left side. Nephrotomy. Nephrectomy. Cure.* (*Hospital Records,* 1900, ii, p. 565.)

Hermann T., age twenty-two, Russian, clerk. Admitted September 11, 1900. Four months ago gonorrhœa; on seventh day of this trouble dull pain in left loin. Temperature 103°–104° F. Pus in urine. Puncture of kidney in another hospital and nephrotomy; evacuation of much pus. Gained flesh after operation. On admission, in left loin scar and sinus discharging pus and urine. Moderate fever. September 13, cystoscopy. Pus escaping from left ureter. In left loin large tumor. September 27, typical nephrectomy. Kidney a large sac with traces of parenchyma and calcareous deposit in wall. Rubber ligature. Uneventful recovery. November 4, discharged cured.

CASE LVIII.—*Pyonephrosis of left side from multiple hemorrhagic infarcts. Nephrotomy. Nephrectomy. Cure.* (*Hospital Records,* 1908–1909, vii, p. 1109.)

Annie C., age twenty-nine, Russian, silk-worker, single. Admitted May 9, 1909. Two weeks ago onset of frequent painful urination. One week later severe pain in left loin, aggravated by upright posture and walking. Chill, fever and vomiting. Appearance of urine unchanged. Had lost 18 pounds. On admission, temperature 103° F., pulse 100. Distinct pressure pain in left loin, where lower pole of kidney could be felt. Right kidney prolapsed, its centre being on level with umbilicus, not tender. Urine clear, amber, acid, 1020, pus, and a few red blood-cells and fine granular casts. Cystoscopy, bladder normal. Ureteral catheterism: Left side, pus-cells and red blood-cells, urea 1.1 per cent. Right side, many white, a few red blood-cells, a few hyaline casts, urea 1.8 per cent. Radiograph negative. May 13, nephrotomy. Three renal arteries were found, one of which, the size of a radial, was crossing and compressing the ureter. This vessel was divided between two ligatures. Kidney much enlarged and congested. Capsule being split, a number

of infarcts were found studding the cortex. One of these foci was excised. Pathological report: Hemorrhagic infarct in purulent disintegration. Subcapsular gauze drainage. Moderate fever. Anorexia and local pain continued, and as patient was evidently losing ground, an extracapsular nephrectomy was done on June 29. Rubber ligature. Specimen: kidney 4 x 4 x 2½ inches. Pathological report: multiple purulent foci in cortex. Ligature came away on eighteenth day. Discharged cured, August 4, 1909.

CASE LIX.—*Miliary pyonephrosis of right kidney from septic infarcts. Nephrotomy. Continued sepsis. Nephrectomy. Suppression of urine. Death.* (*Hospital Record,* 1909–1910, x, p. 1478.)

Theresa H., age forty-five, housewife, Roumanian. Admitted March 30, 1910. Four days ago onset of sharp pain in right loin and hypochondrium, with fever and chills. Pain radiating to right shoulder. Urination neither frequent nor painful. On admission, temperature 104.3°, pulse 104. Great prostration. No jaundice. Marked distention of abdomen with rigidity of parietes in loin and right side. An indefinite, very painful mass can be felt in right hypochondrium. Urine cloudy, amber, acid, 1022, urea 1.2 per cent., loaded with pus, a few hyaline and granular casts. Immediate nephrotomy. Fatty capsule œdematous. Kidney much enlarged and congested, its situs almost transverse, color slaty bluish red. Fibrous capsule very tense. Aspiration yielded only dark blood. Incision of capsule, protrusion of parenchyma, which was brittle and showed many minute infarcts. Parenchyma was split, a drainage tube inserted into pelvis. Escape of large quantities of bloody serum. Kidney replaced and wound sutured. The fever subsided but temperature never reached the normal standard, patient's condition being that of a mild sepsis. April 19, rise of temperature to 104.4° F., pulse 130. Rigors and vomiting. April 25, temperature 105°, pulse 136, severe chill. Great pain in right loin, where a mass can be felt again. Nephrectomy. Elastic ligature. Specimen: Kidney four times the normal size, deeply congested. Cortex studded with innumerable miliary abscesses, many of which were wedge-shaped. Suppression of urine set in, which did not yield to the usual treatment. The temperature descended to the normal standard, but patient died of uræmia on May 5, 1910. No autopsy could be obtained.

Epicrisis.—Primary nephrectomy would probably have saved the patient.

CASE LX.—*Pyonephrosis of right side. Nephrotomy. Nephrectomy. Cure.* (*Hospital Records,* 1898, ii, p. 889 and 899; i, p. 189.)

Tillie L., age thirty-five, United States. Admitted October 27, 1898. Married, three children. During last pregnancy, five years ago, began to have attacks of right renal colic with cystitis. Four months after delivery, cystoscopy. Was told that right kidney was diseased. Pause two years; then severe colic with chill and fever. Since then repeated attacks. Since one year noticed swelling and frequent painful urination. On admission, large, dense, deeply fluctuating mass in right lumbar region, extending inward to median line and downward to level of umbilicus. Urine 1014, acid, no sugar, much pus. October 31, nephrotomy. Drainage. Enormous amount of thick pus, no stone, little parenchyma left. Cessation of fever, improvement of general condition slow, hence discharged with directions to return. Readmitted December 31, 1898. Had gained flesh. January 3, 1899, nephrectomy. Scar incised, peritoneum exposed. Separate ligation of vessels. Tumor being comparatively small, development was easy, only a thin zone of cortex remained. Uneventful recovery. Discharged cured, February 5, 1899.

CASE LXI.—*Calculous pyonephrosis of right side. Nephrotomy. Nephrectomy. Cure.* (*Hospital Records,* 1898, i, p. 551 and ii, p. 260.)

Pauline B., age twenty-five, Russian, seamstress. Admitted December 25, 1897. Severe abdominal pain since three weeks, radiating from loin, where under contracted musculature a tender tumor could be palpated. Repeated vomiting during paroxysms. Temperature 102.2° F., pulse 108, very weak, respiration 28. Urine amber, turbid, acid, 1022, loaded with pus. December 28, nephrotomy. Evacuation of a large quantity of pus. Finger introduced into pelvis could not detect a stone. Drainage. Continued profuse secretion of pus, with occasional exacerbations of fever. January 24, a calculus detected by probing. Attempted extraction by forceps abandoned on account of profuse hemorrhage and collapse. April 23, discharge diminished. Patient declining further operative measures, was discharged.

Readmitted July 4, 1898, with sinus still discharging. Though there was no fever, patient's general condition very poor. July 11, typical nephrectomy after a preceding saline infusion of 1000 grammes. Pulse remained good throughout. Separate ligature of vessels. Specimen: a degenerated kidney, practically a pus bag, containing several calculi. Uninterrupted recovery. Discharged cured, August 11, 1898.

CASE LXII.—*Acute pyelonephritis of right side, due to infection from an adherent diseased appendix. Nephrotomy. Temporary relief. Recurrence of local and general trouble. Nephrectomy and removal of adherent appendix. Cure.* (*Hospital Record,* 1905–1906, vii, p. 695.)

Valeria L., age eighteen, Pole, domestic. Admitted June 7, 1905. Six weeks ago was seized with sharp sticking pain in right loin, radiating toward sternum. Was confined four days. Urination normal. Yesterday sharp, exquisite pain in right hypochondrium, radiating to left shoulder. Chill. Vomiting bile continuously until quieted by a morphine injection. Urination normal, not bloody. On admission, young, strong girl of good color, in great shock; intense pain in right loin and hypochondrium. Pulse 60–65, temperature 99°. Dimensions of liver normal. Deep bimanual pressure of parts between loin and hypochondrium extremely painful. Neither gall-bladder nor kidney felt; no icterus. Muscles very rigid. No tenderness over McBurney's point. Urine 1030, acid, red blood-cells. June 8, exploratory incision revealed normal gall-bladder; palpation showed right kidney enlarged and fixed by dense adhesions. Closure of incision; a second incision made over right kidney, which being delivered was found enlarged, hard, and lobulated. Bloody, turbid serum withdrawn by puncture from pelvis. Opening of pelvis through parenchyma; no stone. Ureteral catheter passed readily into bladder. Tube drainage. The sinus contracted slowly, but was occasionally leaking. As there still was pain in the loin, which we thought to be due to the manifest pyelitis, systematic irrigation of the pelvis of the kidney was practised by ureteral catheter without much benefit. Attacks of sharp pain recurred from time to time, which could not be explained by the condition of the kidney alone. Therefore on October 21, another exploration was made through the loin. The peritoneal reflection being exposed, a cylindrical body,

the size of an index-finger, was found closely adherent to the anterior aspect of the pelvis of the kidney. This was found to be a diseased appendix. It was removed. As the kidney itself was much damaged, it was decided to remove it also, which was done. An uneventful recovery followed, and patient was discharged cured on December 20, freed from the pain she had so long felt in the loin.

Epicrisis.—This puzzling case is instructive on account of the difficulties of the diagnosis, caused by the atypical situs of the appendix. We had to deal with a colon which had not finished its wandering to the right iliac fossa during embryonal life. The cæcum was situated where would be normally the hepatic flexure, and an ascending colon did not exist. An ulcerative appendicitis had caused adhesion of the appendix to the parietal peritoneum, where it was in contact with the pelvis of the right kidney. By osmosis an infection of the pelvis of the kidney had taken place, maintaining a condition, the factors of which were both a chronic ulcerating appendicitis and a pyelitis. A careful search for the cæcum and appendix at the first exploration would have probably resulted in a clear understanding of the situation, in the removal of the diseased appendix and the saving of the kidney.

Deaths after secondary nephrectomy for calculous disease: (1) surgical kidney of opposite side; (2) chronic septicæmia from fecal infection; (3) recent uræmia; (4) late uræmia.

Deaths after secondary nephrectomy for non-calculous disease: (1) recent uræmia; (2) recent uræmia.

(*To be continued*)

THE END RESULTS IN SIXTY-THREE CASES OF OPERATION FOR BRAIN TUMOR.*

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THIS short paper will give the final results of 63 operations for tumor of the brain which have come under my personal observation during the past 25 years.

For 15 of these years, starting in 1887, it was my good fortune to be Dr. W. W. Keen's chief assistant, and as such I assisted him in operating upon the first tumor of the brain which was successfully removed in America.

The results given here are from the records of those cases of his in which I assisted in the operation and after-care, and of those upon whom I have operated myself. I am greatly indebted to him for this opportunity of giving the results in his cases. It will therefore be seen that this is essentially a personal experience, and no attempt has been made to collect the results of other operators.

A statistical record of the results in operations for tumor of the brain by many surgeons would be too great a task, and the resulting table would be, to say the least, of very doubtful value.

Methods of operating, the judgment when to go ahead and when to keep hands off, whether to stop and be content with simple decompression or to plunge into the tissues of the brain and try to find a deep-seated growth, are all great factors in the final results, and must be taken into account when the work of a large number of surgeons is considered. It is a sad fact, but one which must be faced, that there seem to be some operators who give results which others cannot possibly obtain, and who report their successes so soon after the date of operation that little real dependence can be placed upon their findings.

* Read before the American Surgical Association, May 31, 1912.

We all know how many cases there are of tumor of the brain which cannot be localized with any degree of accuracy, and when the skull is opened cannot be found. Then there are a certain, but smaller, percentage of cases where at operation the tumor is found but cannot possibly be removed. And then there are a very small number of cases where the tumor can be readily located, and completely or partially removed.

It is in this small number of cases, and it is very small indeed, that brilliant results are obtained. Most of these are small tumors, many of them arising from the dura, clearly limited in outline. They may be in the brain or only involve the brain by mechanical pressure owing to their size and location. Of this type was the first brain tumor removed by Dr. Keen in December, 1887. It was a simple fibroma of the dura, benign in character, of very slow growth, and absolutely free from any attachment to the brain itself. This patient lived for nearly 20 years, much improved in many of his symptoms, but practically blind as the result of the long-standing intracranial pressure. There have been only two others among all of our cases who have lived for six years, and only one of these is living to-day. All the others have died within three years of operation. There have been tumors where the primary surgical results have been most satisfactory, but most of these, endotheliomata and gliomata, have quickly recurred and resulted in death within a comparatively short space of time.

The value of decompression in relieving the distress incident to the increased intracranial pressure is now so well established and the operation so universally practised that little need be said here in its favor. One of my own cases, rapidly becoming blind, with headache and vomiting, whose skull was opened first on one side and then on the other, in the temporal region, has been able to take up his work of a gardener and has supported himself for over two years. It relieves the intense headache and papilla œdema, thus preserving the eyesight, and, if undertaken sufficiently early, undoubtedly materially prolongs life. Many of our earlier operations for tumor of the brain were too radical, the search for the tumor was too pro-

longed, and great damage was done in consequence to the convolutions and centres. Many of these cases were in desperate straits, were in reality past the point where they could have been benefited. To-day these same cases would have come to operation earlier and with much better chances of relief. I believe now, with increased experience, that unless the location of the tumor is very evident, the tissues of the brain should not be damaged in an effort to find it, and that reliance should be placed upon decompression to relieve the symptoms. In several instances decompression and thus relief of high pressure has permitted the tumor to push its way to the surface of the brain, and at a second operation be removed.

We have had six tumors of the dura. Of these, three died within a few hours from hemorrhage, and three survived operation. One of these was our first, who lived for nearly 20 years. The second, after making a brilliant surgical recovery, died of a recurrence of the disease, an endothelioma, 108 days after operation. The third recovered from the operation and was reported five months afterward as improved, but it has been impossible to learn her subsequent history. Dural tumors are particularly prone to bleed, and this is due of course to the nature of the growth, which is almost always an endothelioma. All the vessels are engorged, the smaller ones dilated, and the bleeding general over the dural surface. It is extremely difficult to control this general bleeding; ligatures are of little use, and at times it may be necessary to perform the operation in two stages. Venous bleeding is much more fatal than arterial, and I have seen several patients die from the loss of an amount of venous blood which did not appear very great.

There were in all eight simple cysts of the brain substance —four of these were cerebral and four cerebellar. Six of these recovered from the operation of simple drainage, and one at least has lived comfortably for five and a half years, and is living to-day. It was necessary however to drain this cyst a second time. There were in addition to these simple cysts, and by this I mean cysts which had such thin walls that no attempt at removal could be undertaken and drainage had to suffice, three cases of cystic degeneration of a distinct new growth.

One was a broken-down gumma; a second, cystic degeneration of a sarcoma of the cerebellum; and the third, a cyst with thick walls which was dissected out completely. This was believed to have undergone sarcomatous degeneration, but the patient lived for six years in apparently good health. Finally there was a recurrence and death followed a second operation.

The total number of cases was 63. In 33 the tumor could not be found at operation, and a decompression gave more or less relief to the patient.

In 30 cases the tumor was found and removed at operation. In 14 of these the new growth was completely gotten away. In 9 the growth was only removed in part, owing to its infiltrating character. In 8, cysts were found and drained.

The operative mortality is very high, much higher in fact than I had supposed until these histories were studied with care: six patients died within the first five days, four of these within 24 hours, when the skull had been opened and no tumor found. One of these died of pneumonia in five days, and one of œdema of the lungs in 17 hours. Thirteen died within ten days of the operation, of those in which a tumor was found and removed; eight of these died within 36 hours, and one from chloroform.

One case of cerebellar cyst died in five days, as a direct result of operation.

Nineteen deaths, all told, as a direct result of operation, that is within ten days, in 63 cases is a very high percentage of mortality (30 per cent.).

The final or end results in all of these 63 cases are very bad indeed.

One case of cyst of the cerebellum is alive and well at this time, five and a half years from the date of the first operation and three years from the date of the second operation of draining the cyst.

One case of glioma of the brain is living and comparatively comfortable, three years since the first operation and eighteen months since the second operation. This patient has a recurrence of his growth and must soon go.

There are three others now living, but three years have not yet passed since they were operated upon.

In our earlier work the value of decompression as a life-prolonging measure was not fully recognized and was not urged upon our patients as it would be to-day. Many cases of tumors of the brain which could not be localized with reasonable certainty were therefore allowed to suffer the violent headache, vomiting, and loss of sight which we now know could be relieved.

It seems to me the time has come to give a plain statement of facts in regard to the end results, and by one who has had an experience now covering a period practically of 25 years. I do not know what the statistics of other operators may show in the way of end results, but I doubt, if the truth be told, if their experience, covering the same number of years, would offer much more encouragement. Occasionally the results are so brilliant and often so unexpected that these poor unfortunates should be given the chance of relief which operation alone affords. The possibility of several years of life made comfortable and in some instances of great usefulness may well be striven for, and the dangers of operation, while very great, are not to be compared to the benefits which may be obtained.

The operation of decompression as now practised is one of such simplicity and safety and in the want of accurate localization should always be advised. Many and in fact almost all of our earlier cases submitted to operation when the tumor could not be found should not be considered as simple decompressions. As I have stated, we then believed in searching the brain for the growth, and thereby inflicted so much damage to the tissues that the mortality rate was very high. In the past few years every case but one of simple decompression for pressure has made a good surgical recovery. This one, a cerebellar growth, was decompressed in the temporal region when it should have been over the cerebellum. The error was I think pardonable, as the autopsy showed acute dilatation of the lateral ventricles, producing great pressure and total palsy of every nerve passing through the great sphenoidal fissure.

BULLET WOUND OF THE SPINAL CORD BETWEEN THE FIRST AND SECOND DORSAL VERTEBRÆ; LAMINECTOMY; REMOVAL OF THE BULLET; COMPLETE RECOVERY.*

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E. H., female, age fourteen years; in perfect health until July 18, 1911, when, while riding in an automobile, at Wilton, Connecticut, she was shot in the back. A bullet from a .22 calibre rifle shot at a distance of 10 to 15 yards entered the spine between the first and second dorsal vertebræ, almost in exact line with the spinous processes and travelling in a direction nearly at right angles to the plane of the back. The girl immediately lost complete control of the lower extremities, and partial control of the upper extremities, and both bladder and rectum sphincters, and suffered very severe pain. She was taken in the automobile to the home of her uncle, Dr. Warren Hitchcock, of Norwalk, Conn., about four miles distant. The latter states that there was immediate and complete loss of power in the left leg and nearly complete in the right. She could move the fingers and forearm slightly but not the upper arm. There was considerable hemorrhage at the time but not much after her arrival at the house. Pain was severe and continuous and required a hypodermic of one-fourth grain of morphine every six hours to relieve it. Patient described the pain as being "all over." The loss of power increased in the right leg and involved the arms, especially the right. She also complained of difficulty of breathing and of pain in the chest. There was complete loss of power of urination and no movement of bowel without enema. I saw her about 24 hours after the accident, at which time she was apparently suffering severe pain in spite of considerable doses of morphine.

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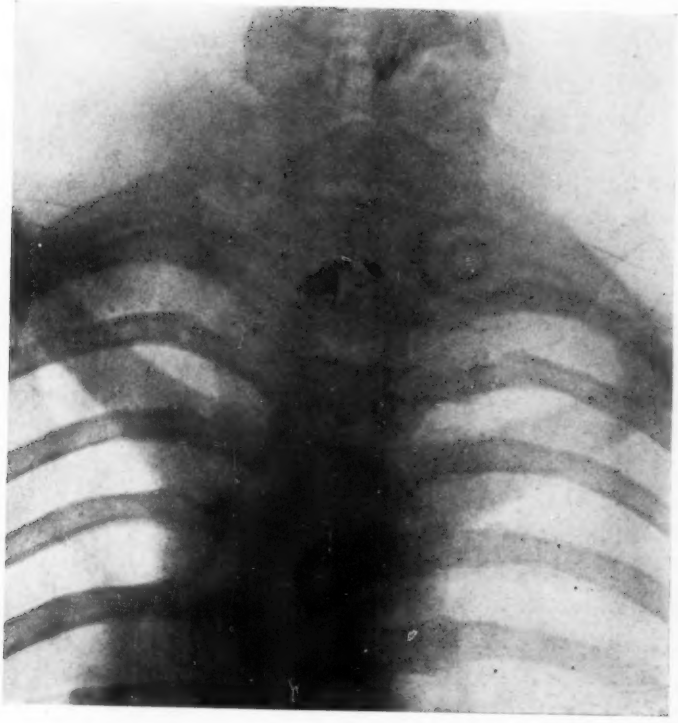
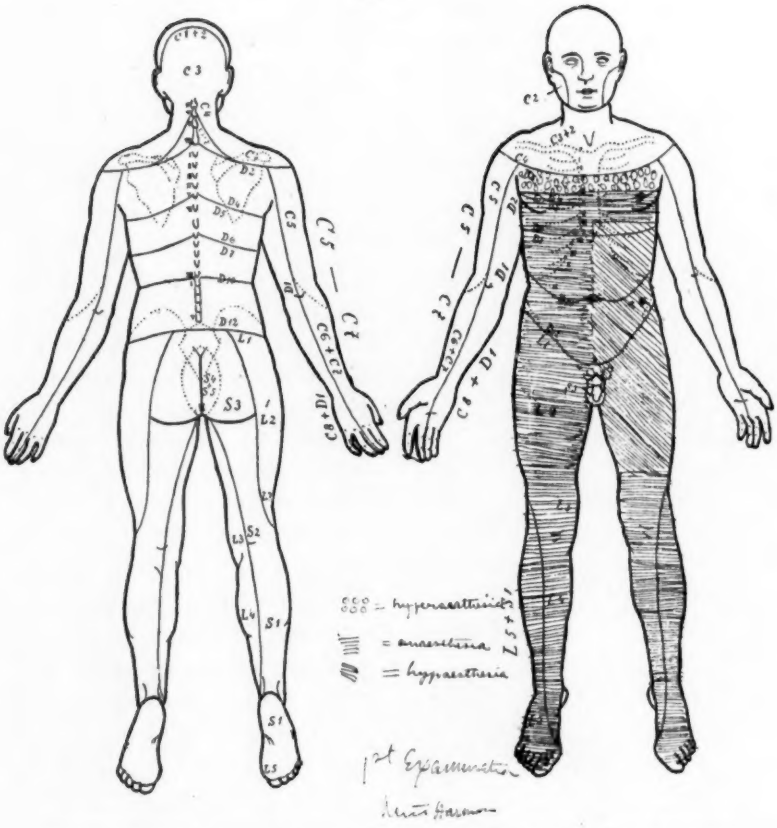
* Read before the American Surgical Association, May 29, 1912.

FIG. 1.



Skiagraph showing presence of bullet lodged in spinal cord.

FIG. 2.



Diagrams showing changes in nerve sensibility four days after wound of spinal cord.

Examination showed a small wound, apparently the entrance of a bullet, in almost exactly the median line of the back opposite the second dorsal vertebra; hyperæsthesia general but especially marked below the level of the second dorsal vertebra.

I advised that an X-ray be taken as soon as possible, and the next day Dr. L. V. Cole, of New York, saw her and took several photographs. His report reads as follows: "Contour and structure of the spine and ribs show distinctly. The bullet and several fragments show distinctly and are lodged between the first and second dorsal vertebræ. There are two large fragments and several small ones. The large fragment lies just to the left of the median line, and the larger of the smaller fragments lies just to the right of the median line. Viewed stereoscopically, the one to the left appears to be a trifle deeper than the one to the right. I find no evidence of the bullet's having fractured the vertebræ, and it appears to have lodged between the laminæ rather than to have perforated one of them. Diagnosis: From a study of these plates one is justified in stating that the bullet is in the position described in the findings and that it has entered the spinal column between the laminæ rather than through one of them. Whether the bullet has perforated the cord or merely lies against it causing the pressure, I am unwilling to state with certainty, but I believe that there is sufficient doubt of this having severed the cord to justify one in removing it."

I decided to operate as soon as possible, and on July 22, the fourth day after the accident, the patient was brought to New York by train and ambulance. She arrived at the General Memorial Hospital at about 11 o'clock and the operation was performed an hour later, following a careful neurological examination by Dr. E. G. Zabriskie, of the Neurological Institute, whose report reads:

First examination, one hour before operation: "Well-nourished young girl of medium build. Head, neck, and face normal. Mobility of both arms good, although active and passive movements of right arm cause intense pain. Paralysis of both sphincters. Both legs completely paralyzed. Knee-jerks active; ankle-jerks active; pseudoclonus, left side. Babinski present on left side; right side doubtful. Reflexes of both arms present. Abdominal reflexes absent. Pupils equal, respond promptly to light and accommodation. Sensory disturbances (see chart). At the

level of the fourth rib there is a zone three inches wide, in which all sensation is abolished; above this there is a zone of hyperæsthesia which shades off into normal sensibility. Below the zone of anæsthesia the right half of the trunk and right leg show a complete loss of pain and temperature sense, and loss of perception of light touch; heavy touch, *i.e.*, pressure, is perceived and if deep enough causes pain. The left half of the trunk shows hyperæsthesia, hypalgesia, and thermohyperæsthesia, as far down as the middle of the left thigh. From this point downward cutaneous sensation is completely abolished. There is complete inability to localize cutaneous stimuli anywhere below the fourth rib. Deep muscular sense lost on left side; partially preserved on right side."

Two hours after admission I performed the operation with the assistance of my associate, Dr. Wm. A. Downes, and the house staff. A longitudinal incision, 3 inches in length was made in the median line over the spinous processes, on a level with the second dorsal vertebra. A small, ragged wound was found and traced inward. The spinous processes of the first and second dorsal vertebræ were removed with Rongeur forceps and chisel, and an opening made in the lamina, about 1½ inches in length; exposure of the dura, showed a ragged hole about ⅜ inch in diameter. The bullet had perforated one of the laminæ. This opening was enlarged by a vertical incision, and the cord exposed. There was considerable flow of cerebro-spinal fluid. Following the track of the wound into the cord itself, the two fragments of the bullet, as shown by the X-ray, after some searching were found embedded in the substance of the cord, about ½ inch from the surface. No attempt was made to suture the dura. A small cigarette drain was passed in the wound extending to the dura and the skin wound carefully closed, except that sufficient opening was allowed for drainage. The patient was put upon a water-bed and given sufficient morphine to control the pain. Very free discharge of cerebro-spinal fluid continued for ten days and then gradually began to diminish. At no time was there any suppuration. The patient was kept on a water-bed for about six weeks. The excruciating pain gradually lessened. After three days there was marked improvement in her ability to move her arms and hands and within a week she was able to use one foot a little. The improvement was gradual, but continuous and at the end of two months she had regained considerable power in

the muscles of the lower extremities. She sat up for the first time on September 2d, started to walk on crutches in the latter part of October, and returned home November 1st. By the 20th of November she was able to walk without support. A photograph taken December 6, 1911, shows her out in the yard throwing snow-balls, with almost complete restoration of power. She is at present perfectly well, has only a slight limp in her left leg, can play piano, and do nearly anything she ever could, but run fast.

A case closely resembling my own, is that of Pilcher's, published in the ANNALS OF SURGERY, vol. xxxviii, p. 812, 1901, although in this case the bullet was not imbedded within cord, and it is not certain that it penetrated the canal. The patient was a boy 11 years of age who was shot with a .22 calibre rifle bullet, entering just below the episternal notch, ranging upward and backward and apparently passing through the spine between the fifth and sixth cervical vertebræ. The boy was paralyzed below the clavicles, both as regards motion and sensation; he had priapism, involuntary urination and defecation. He gradually improved, regained control of the bladder and bowels and began to have voluntary movements in his limbs. At the end of a month, laminectomy was performed, but no injury of the cord was detected. Later he regained considerable muscular control as well as sensation. An X-ray taken a year after the injury showed the bullet embedded in the spinous process of the sixth vertebra.

Winslow in reviewing the case states that he is not convinced that this was not a case of concussion, rather than a perforation of the cord.

Winslow's (Trans. South. Surg. and Gyn. Ass'n, vol. xxiii, p. 432) case of complete transverse destruction of the spinal cord from pistol wound, without penetration of the spinal canal, is one of extraordinary interest. The patient, male, white, 24 years of age was shot with a pistol in the left side, the bullet entering between the seventh and eighth ribs, just posterior to the midaxillary line. The patient fell immediately to the ground and was paralyzed from near the umbilicus downward, both as regards sensation and motion. The patient was promptly taken to the hospital, where examination showed complete muscular and sensory paralysis below a line extending around the body 1½ inches below the umbilicus in the median line in front and curving upward and backward along the upper border of the twelfth rib to the spine. Three days later laminectomy was performed by Dr. Winslow, the laminæ of the seventh, eighth, ninth and tenth dorsal vertebræ being removed. There was no blood in the canal and the dura was uninjured; the bullet was not discovered. The cord was not severed, nor did it appear to be altered, but subsequently some grumous material escaped from the cord. The patient was not improved, nor was he apparently made worse by the operation. The wound healed per primam. The patient became emaciated and later developed bed-sores, but was still living at the time of the report.

Winslow reported a second case of pistol shot wound from a .32 calibre bullet which entered the second dorsal vertebra, in a woman aged eighteen years. The victim fell forward with paraplegia, paralysis of the left arm, dilatation of the left pupil and alteration of the pulse. Later there was partial restoration of sensation and motion to the left arm. Complete anæsthesia extended to the first rib on the left, to the third on the right. Clinical diagnosis: Pistol shot wound of the second dorsal vertebra, crushing or otherwise injuring the spinal cord. No operation; death on the twenty-first day following the injury. Autopsy by Professor Michael: The bullet cut the posterior margin of the left sternocleidomastoid muscle, then passed behind the brachial plexus, cutting a small nerve, then passed between the anterior and middle scaleni muscles, broke the tip of the transverse process of the seventh cervical vertebra, penetrated the body of the second vertebra and impinged on but did not penetrate the spinal canal. There was some bloody serum in the canal and spinal meningitis was present. The cord was not penetrated or compressed, but was disintegrated, and much reduced in size opposite the location of the bullet.

These two cases show that very serious lesions may result from bullet wounds of the spine without penetrating the cord. Winslow believes the injuries due to concussion, though he finds it difficult to understand how a complete transverse destruction of the cord can occur without a direct impact.

A wide divergence of opinion apparently still exists as to the proper method of treatment for bullet wounds of the cord.

Winslow, after a report of his cases and a review of other cases of bullet injury to the cord, concludes:

1. That serious and even fatal lesions of the spinal cord may be produced by concussion, without direct impact.

2. That in gunshot injuries, with a probability of complete severance of the cord, laminectomy should be performed, foreign bodies and clots removed, bleeding arrested, and if the cord has been divided, the separate ends should be approximated with sutures.

3. Care should be exercised not to destroy any nervous fibres or tracts that may still be intact.

In the discussion of Dr. Winslow's case, at the meeting of the Southern Surg. Assn. in 1911, Dr. Thompson, of Galveston, laid great emphasis on the physiological fact that the spinal cord is incapable of regeneration. He stated that the

indications for operation can thus be reduced to absolute simplicity. Any injury attended by the immediate onset of paralysis and anæsthesia has probably destroyed the conductivity of the cord, and if there is no displacement of the vertebræ or pressure on the cord by spicules of bone or anything like a bullet or blood clot pressing on the cord, operation can hold out no hope of improving the condition of the portion of cord actually injured. He asks "What possible good can we expect from mere exposure of the cord? Are we not more likely to do harm by the extra risk of sepsis?" He further states, "I have removed bullets from the pedicles of the vertebræ in two cases where the primary symptoms at the time of injury were those of a complete transverse lesion. Later on, motion and sensation were restored in part, but both patients showed evidence of descending degeneration in the lateral columns. I never expected to cure the patients by the operation, because I knew that the mere removal of the bullet could not arrest the degeneration or favor regeneration."

A case reported by Dr. Fort, of Nashville, in connection with the discussion of Dr. Winslow's paper, supplies evidence directly contrary to the opinion held by Thompson and others, that operation can do little good. Dr. Fort's patient was a young man of twenty-five years who was shot in the back with a 32-calibre revolver, the bullet entering the abdomen, fracturing the eighth dorsal spinous process. Laminectomy was done 23 hours after the injury. On opening the dura a spiculum of the transverse process was found penetrating the cord near the bullet or a portion of the bullet. In this case there was complete paralysis from the beginning, both motor and sensory, with priapism, retention of urine and incontinence of fæces. The dura was closed with No. 1 sterile, plain catgut. The patient made a perfect recovery and was leading the active life of a railroad contractor at the time of the report, four years later.

This case, equally with my own, shows the great importance of early operation in bullet wounds of the spine involving injury to the cord.

In the "System of Practical Surgery" (v. Bergmann, vol. ii), it is stated that "recent injuries of the spine do not demand surgical interference any more than stab-wounds of the cord. If the surgeon follow the rules laid down by modern military surgery, he will leave the wound alone and protect it from secondary infection by using an antiseptic dressing. Even when nervous elements are injured, he will be inclined to adhere to this form of treatment. Gun-shot wounds of the cord demand interference just as little as crushes and stab-wounds. The operation serves only the purpose of removing the compression produced by fragments or the projectile. In gun-shot wounds a differential diagnosis cannot be made for several days or weeks, so that one should generally wait for a time before interfering. An early operation is indicated only in cases in which the cord symptoms indicate pressure due to fragments or from the projectile. It remains to be decided whether in these cases it is not best to wait until the skin-wound has healed, so as to be able to operate with a greater chance of preserving asepsis."

Prewitt ("Gun-Shot Wounds of the Spine," ANNALS OF SURGERY, 1898) whose experience was based upon cases seen in the Spanish War, believes in operating when the region is accessible and the condition of the patient justifies operation. Of 58 cases of wounds of the spine seen by him, 33 ended fatally; and of 25 which were operated upon, 12 recovered.

Schmidt in 1902 (Schussverletzungen der Wirbelsäule in *Deutsche Milit. Zeitschr.*, 1904) at a meeting of surgeons in Berlin, spoke in support of early operation. He stated that German government statistics show that of those operated upon for injuries of the spine, 62.5 per cent. lived, while of those who were not operated upon, only 24 per cent. recovered.

Carson, of St. Louis, states that the treatment as laid down by modern military surgeons is to leave the wound alone, only protecting it from infection from the outside. This applies to gun-shot wounds as well as stab-wounds. After the sensory localizing symptoms have appeared, and when a radiograph shows that the bullet or a splinter of bone is causing compression of the cord, then operation for the relief of such pressure is indicated. The question of waiting until the wound caused by the projectile or weapon has healed, is one that must be settled in each individual case. If fitting treatment can be employed, it is perhaps better to wait, as thus the danger of infection is made less. However, it must be remembered that pressure upon the spinal cord or its membranes, when continued for long, is apt to result in local destruction of the cord.

Krajewski (*Jahresbericht über die Leistungen und Fortschritte aus d. Gebiete der Neurologie und Psychiatrie*, vol. x, 1906) after a careful search of the literature, found 32 cases of laminectomy with or without removal of the bullet, with 24 deaths. Actual improvement as a result of the operation occurred only in one instance, the case of Preusth, ANNALS OF SURG., 1898, vol. xxviii.

Krajewski points out the dangers of the operation itself and refers to one case in which the patient lived for five years after the injury and

then died six days after operation. Of 22 cases treated conservatively, 16 died.

Krajewski believes that operation should be resorted to only if it can be done immediately after or on the day following the injury. It does not serve the purpose of preventing paraplegia, but may obviate an infection and favor circulation at the site of injury. In the later stages operation is indicated only if new symptoms develop as a result of the inflammation.

Woolsey (Keen's Surgery, vol. ii) in dealing with the subject of gunshot wounds of the spine, states: "If the bullet is in or very close to the canal, or if the bullet tract is likely to be or become septic, it is best to operate early. If the skiagraph shows fragments or splinters of bone in a position to press upon the cord, they should be removed by early operation. If infection occurs, operation is indicated; otherwise nothing is to be gained by operation, as the damage to the cord is done."

Thus it will be seen that most of our modern authorities on the subject either advise against early operation or advise it in a very cautious and conditional way.

This is not the time, nor do I feel myself competent to discuss the vexed and complicated question of the possibility of the spinal cord's recovering its function after actual destruction of its axis cylinders. The clinical evidence thus far is insufficient to settle this question and in my opinion it can be settled only by careful experimental work. Such experimental work has already been begun by Alfred Reginald Allen, of Philadelphia (*Jour. Am. Med. Assn.*, Sept. 9, 1911, pp. 878–80). This preliminary work gives us important new data bearing upon this subject, and his further experiments, already outlined, are full of promise. He has succeeded in determining the amount of impact the spinal cord in an animal can receive and yet recover its function. He has further shown that a median longitudinal incision into a spinal cord is provocative of no symptoms of note. In five dogs whose spinal cord had been subjected to a hyperimpact of 540 gram-centimetres, a median longitudinal incision from 1 to 1.5 cm. long, was made directly through the impact level and passing altogether through the spinal cord. These dogs made uneventful recoveries and yet this impact was sufficient to have led to dire consequences, had not the median longitudinal incision been made. His control experiments showed that the dogs would

have died, had not the spinal cord been drained. His tentative conclusion is:

"That in cases of fracture dislocation of the spinal column in the human subject, in which there exists the symptom picture of transverse lesion of the spinal cord, it were well to perform the operation of laminectomy at the earliest possible moment, and if the cord be not completely severed, to make a median longitudinal incision through the area of impact by means of a fine canaliculus knife in order to drain the injured tissue of the products of œdema and hemorrhage."

I believe the dangers of laminectomy, which have been so strongly emphasized by Thompson and others, to have been greatly exaggerated. Bailey and Elsberg (*Jour. of the Am. Med. Assn.*, March 9, 1912, pp. 675–79) in their recent report state that while "laminectomy must always be classed as a major operation, much of the gravity associated with it is due to the life-threatening conditions for which it is undertaken. Except for section of the posterior roots for spasticity and pain, the laminæ are removed by the surgeon only for conditions of the most serious character, most of them direct menaces to life. The burden of mortality, therefore, which appears in any statistics of laminectomies should be borne by the disorders for which the operations were undertaken, rather than by the operations themselves. If the cases of spinal cord disease or injury in which the surgeon attempts to remedy the irremediable or to operate on patients almost moribund, are left out of account, it will be found that laminectomy in experienced hands is neither a particularly hazardous nor a trying operation. In our experience, if the five cases just cited—all hopeless from the onset—were excluded, we would have done twenty-nine primary laminectomies without fatality, so that we have come to look on laminectomy in a patient in good condition as a fairly safe operation." I further agree with Bailey and Elsberg in their conclusion that "Even in the absence of increased intradural pressure or a discoverable lesion, the operation of laminectomy and incision of the dura may be of great benefit."

"For the reasons above stated and on account of its relative safety in experienced hands, exploratory operation should be done more often."

In my own case I believe it fair to state that the patient's life was probably saved by the operation. Certainly her ability to enjoy life is due to early operative interference.

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THE TREATMENT OF THE DEFECT OCCASIONED BY PARTIAL EXCISION OF THE INFERIOR MAXILLA.*

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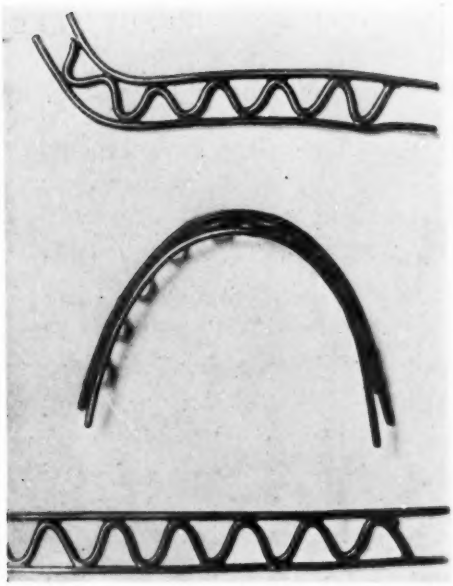
A LONG and on the whole a bitter and disappointing experience in the operative treatment of epithelioma of the buccal mucous membrane and lips, in which, by extension or by metastasis, the inferior maxilla or its periosteum had become involved, tempts me to give some personal experience with these cases, rather with a hope that it may awaken some discussion than with the idea of advancing anything new in operative technic. In a prefatory way I may say that at least on the Pacific Coast the surgery of the mouth, lips, and neck is very much inferior to that of any other part of the body. Much has been published, both in journals and text-books, as to the necessity of thorough and complete dissection of the mental, submaxillary, and cervical glands in cancer of the lip and mouth. Nevertheless the surgeon is too often content to confine his work to the lip or mouth alone; the dermatologists still continue to use the X-ray and to discuss the relative merits of various escharotics, with or without the use of the curette, giving no thought apparently to the question of metastases; and the general practitioner does not seem to view with the same concern cancer of the lip or buccal cavity that he does cancer of the breast or cervix. The fear of mutilation by the knife together with the alluring prospects held out by the cancer sharps that infest every city are also potent factors in many cases. The result is a large number of cases of cancer extending to and involving the lower jaw, or cancerous glands attached to its periosteum, the primary growth healed or not as the case may be. The fear of deformity and mutilation

* Read before the American Surgical Association, May 30, 1912.

following removal of a portion of the jaw in these cases often leads to incomplete work, for in many cases it is only by such removal early that the growth can be widely enough excised. Cancer of the lip and cancer of the buccal mucous membrane are not within the scope of this paper, but were these affections properly treated in the outset, there would be little call for a discussion of the subject; for with the exception of epithelioma originating in the alveolar process, and primary sarcoma, there are practically few conditions that call for excision of portions of the mandible together with its periosteum, except growths resulting from metastases in the sublingual or submaxillary glands, or from direct extension of an epithelioma of the mouth. Since the fear of deformity resulting from loss of symmetry in the two halves of the mandible, and of disturbance in the relation of the teeth resulting therefrom, are the factors chiefly responsible for the hesitation to do a properly radical piece of work, I hope to show that such deformity can be prevented to a large extent in most cases, and in some, almost entirely. In order to prevent deformity, it is necessary that the defect occasioned by the removal of a portion of the jaw be filled in by some material; and the only material that will do the work permanently in my experience is bone. The conditions, however, are not favorable for transplantation of bone immediately, and if some means are not taken to prevent cicatricial contraction during the healing of the wounds, the deformity will already have occurred and cannot subsequently be overcome. For a number of years I used heavy silver wire as large as telegraph wire to keep the cut surfaces of bone separated the proper distance; later, I used silver plates and recently have been using a light truss or bridge of silver wire designed, I believe, in the first place by Dr. J. B. Murphy and called to my attention by Dr. James Eaves, Instructor in Surgery in Stanford University (Fig. 1). At first the hope was that these supports would be buried in the tissues and remain permanently, but with all of them the result has finally been the same. They have ulcerated through the skin and ultimately required removal. Many, however, have re-

mained in place for a year or more, and I have been surprised to notice how little subsequent deformity there was after removal, when they could be kept in place for six or eight months. While there was practically no new formation of bone, no further cicatricial contraction seemed to take place, and the deformity was very much less than when no effort at all had been made to keep the ends of the bone apart. In some the deformity was hardly noticeable, and the patients were able to masticate reasonably well on the sound side. In cases where it is necessary to remove the anterior or mental portion of the jaw, I know of no device that will so well replace the lost bone as the curved truss here shown. (Fig. 1.) This is a mutilating operation at best and usually a hopeless one, yet I have one patient who is still wearing the truss eight months after operation and without any signs of recurrence at the present time. In this as in other cases, the truss has become entirely covered up inside the mouth, but has ulcerated through the skin and will soon have to be removed (Figs. 2, 3, 4, and 5). The deformity in these cases is of course very great, but it is by no means so great when the truss is used as when it is not, and if it can be left in place for six months or more there is but little increase in the deformity after its removal. By its use also can be prevented the gravitation or retraction of the tongue onto the larynx which is the cause of much trouble for the first few days after this operation. Murphy has recently used successfully a framework of this kind to take the place of the body of the jaw and the articular process which was removed for sarcoma, and succeeded in getting good functional results; and I hope the result will be permanently successful. After implantation the truss becomes surrounded by a gelatinous granulation tissue, which sometimes persists and sometimes becomes firm cicatricial tissue, which in my experience, however, sooner or later at some point breaks down with the overlying skin, exposing the bridge. I have removed the truss under such circumstances just before the skin broke down, and after changing its shape, replaced it, to have the same result follow a few months later. The grafting of bone into these defects is the ideal and I believe

FIG. 1.

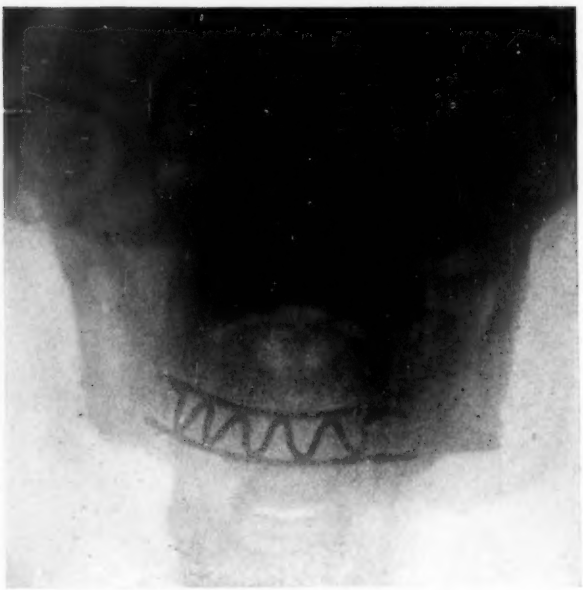


Trusses made of silver wire for insertion after partial removal of inferior maxilla.

FIG. 2.

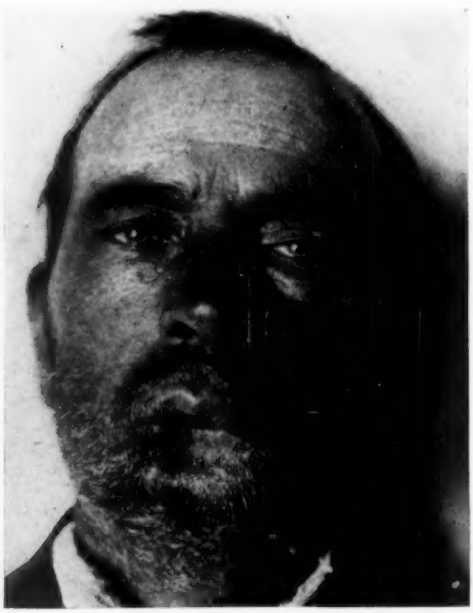
Skiagram showing wire truss in position; lateral view.

FIG. 3.



Skiagram showing wire truss in position; anteroposterior view.

FIG. 4.



Showing external appearance of patient wearing wire truss (as in Fig. 3).

FIG. 5.

Lateral view of patient shown in Fig. 4.

FIG. 6.

Showing prevention of loss of symmetry by bone graft after partial removal of inferior maxilla. Condition nine months after removal.

FIG. 7.

Same patient as in Fig. 6; lateral view.

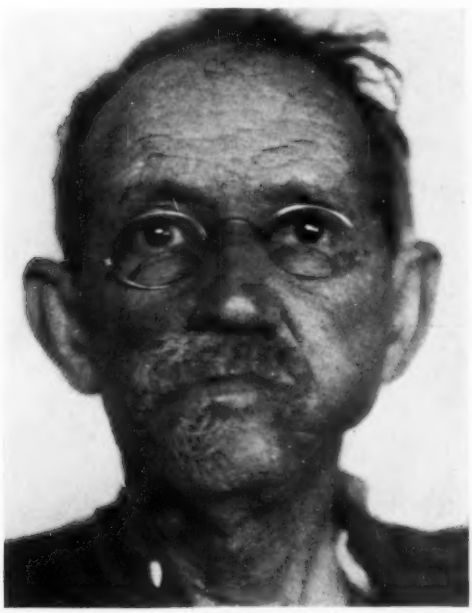
FIG. 8.

Same patient as in Fig. 6, with mouth open.

FIG. 9.

Showing wire truss supporting jaw after removal from symphysis to angle.

FIG. 10.

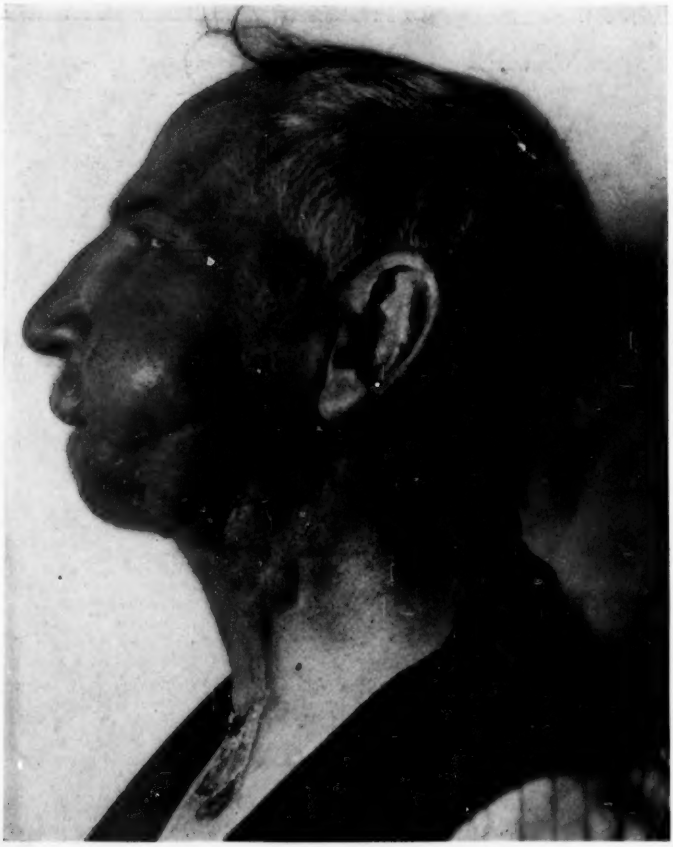


Condition after removal of angle of mouth and left side of inferior maxilla from symphysis to angle.

FIG. 11.

Same patient shown in Fig. 10; lateral view.

FIG. 12.



Showing early condition after removal of cheek and part of lower jaw, with plastic flaps from neck to reform cheek, with wire truss to support jaw.

FIG. 13.

Showing wire truss in place after resection of half of body of lower jaw.

the only permanently successful method of maintaining the symmetry and function of the jaw. It is necessary to prevent contraction from occurring during the interval between the removal of the bone and the healing of the wounds, and this may take a month or longer. When the teeth on the sound side are numerous and firm enough to stand the strain, they may be prepared beforehand with the aid of a dentist, so that a few days after the operation they may be clamped firmly to those of the upper jaw. While all of the teeth are loosened somewhat under the strain and the patient is not altogether happy, deformity has been prevented this way until the wound was healed and I could separate the flap, freshen the ends of the bone, and wedge in between them a section of rib. This takes the strain from the teeth, and the clamps are left in place until the bone is firmly united—six or eight weeks later. I have had but one case in which I was able to do this successfully, for the age of the patient is generally such that the teeth are too few or too loose or decayed to stand the strain. In this case (Figs. 6, 7 and 8), which was presented to the Clinical Society at its meeting in San Francisco last year, the grafted section of bone had to be subsequently removed in order to reach a recurrence of the growth in the floor of the mouth, but by anchoring the teeth contraction was prevented so that at the present time, nine months after its removal, there is scarcely any loss of symmetry with the mouth open or closed, as can be seen in the photographs, and the teeth can be brought together on the sound side so as to permit of satisfactory mastication, although the left side of the jaw is gone from the angle to the lateral incisor. The patient is so well satisfied with his condition that he does not wish to submit to the insertion of a piece of rib a second time. In cases where the teeth cannot be utilized, contraction may be prevented by the temporary use of the silver truss or bridge; and if necessary this may be left in place for months until conditions are favorable for bone transplantation. Then it may be removed and a section of rib inserted in its place. This plan, for reasons stated above is the one that will have to be most frequently employed, and

while the bone grafting is not always successful, it should be so in a large proportion of cases with proper technic. In cases where the loss of soft parts has not been too great, the mucous membrane of the cheek should be sutured to that of the floor of the mouth or the side of the tongue, and it is generally possible to get primary union in these cases, except at the line of section in front near the incisor teeth where it is usually not possible to cover up entirely the cut surface of the bone. The sutures should be placed so that the knots are toward the buccal cavity. The ends of the truss or bridge should then be inserted into holes drilled into the bone and the skin flap sutured over it with provision for drainage at each end of the incision. The posterior drainage opening usually closes promptly, but the anterior one takes time and sometimes does not heal until a small sequestrum is separated from the maxilla. When it has finally healed and the conditions are favorable for bone grafting, the wound may be reopened, the truss or wires removed, and all granulation tissue thoroughly scraped out, the wound enlarged sufficiently to receive the graft without opening the oral cavity, the ends of the bone freshened, the graft put in place, and the wound sutured without drainage. The original wound may suppurate, but it will rarely occur if sufficient care be used in preparation of the mouth and teeth; this means in many cases the removal of all remaining teeth, certainly all useless or decayed ones, and those that are preserved should be thoroughly scraped and polished by a dentist beforehand. If this is thoroughly attended to there is little tendency to infection. Figs. 9, 10 and 11 were taken two weeks after operation on a case of epithelioma originating in the alveolar process of the left side of the jaw and involving the buccal mucous membrane. The few remaining teeth were extracted previous to operation. There was primary union of both mucous membrane and skin. The angle of the mouth was removed at the operation together with the jaw from near the symphysis to the angle. The submental and submaxillary glands were removed at the same time, the cervical glands later. The truss was removed three months later, for the

reason that the skin was about to break down over it at one point. Its shape was changed and it was replaced but was finally removed a few weeks later on account of recurrence in the cheek. Following this later operation there was remarkably little cicatricial contraction and the deformity due to loss of the jaw is surprisingly slight. If the loss of the buccal mucous membrane is too great to permit of suture, it will be necessary to turn in a flap from the lower part of the neck to form a new lining for the mouth, and often another flap from the neck to cover this one, if the skin also requires removal. These flaps usually heal by primary union in my experience when the teeth have been properly attended to; when their pedicles have been severed, after ten days, the flap lining the mouth is sutured to the freshened mucous membrane of the floor of the mouth and the side of the tongue, and between it and the external skin flap is placed the silver wire truss, to keep the ends of the maxilla the proper distance apart until conditions are favorable for bone grafting. In some cases this condition never occurs and the truss has to be removed, but the result, as has been stated, is very much better than if no truss at all had been used; the accompanying photograph illustrates such a case (Fig. 12). It is one of cancer of the lip treated by X-ray until the growth had extended from the angle of the mouth to the last molar tooth. The photograph was taken the middle of January, one week after replacement of the pedicles. The granulating surface below the clavicle indicates the portion of the flap that was used to make the lining of the mouth. The posterior drainage opening was closed but there was still some discharge from the anterior opening. At the present time the truss is still in place, but multiple skin metastases have developed all over that side of the neck and the condition is hopeless. With subperiosteal resection the problem is simpler; in cases of necrosis the sequestrum should not be removed until the involucrum is sufficiently developed to maintain the shape of the jaw; or if this for some reason must be done, the jaw may be fixed by some form of interdental splint or the ends kept apart by a plate until new bone has filled

in the defect, which it can generally be depended upon to do. In benign tumors the periosteum can generally be preserved and regeneration of bone hoped for, the cut ends of the bone being kept separated by a plate in the meantime. I have never had the pleasure of dealing with a benign tumor, however, large enough to call for removal of the entire thickness of the lower jaw. In the absence of the periosteum there is often a considerable quantity of new bone formed from the cut ends, and, following Macewen's work, I have recently been trying some experiments to see if this could not be encouraged to such an extent as to fill in a gap of a couple of inches, by substituting some other membrane for the periosteum; and while something has been accomplished, I am not able as I hoped to report positive results. In the few cases in which I have successfully transplanted bone into the jaw I have used sections of rib with the periosteum attached, and in one case in which the fragment had subsequently to be removed, after a lapse of several months, on account of recurrence in the floor of the mouth, bony union was perfect and the shape and appearance of the grafted rib was the same as when it was inserted. Whether a rib without periosteum would unite in the same way or merely act as a bone filling to be replaced by bone growing into it from the cut ends, I am not able to say. I have used wire or a truss many times in cases that were practically hopeless at the time of operation, so far as ultimate recovery was concerned, and the truss particularly has been proved to be of great assistance. The experience gained from its use will lead one to hesitate less to do early radical work in cases of malignant growths involving the gums or alveolar process of the lower jaw, and has led me long ago to abandon any attempts at intra-oral work in such cases, the results of which have been almost uniformly unsuccessful in my experience. I do not hesitate to remove any portion of the inferior maxilla that necessity requires, feeling confident that if the disease does not return, permanent deformity resulting from such removal can be prevented by the use of the truss at the time of operation, and subsequently by bone grafting.

SURGERY OF THE THYMUS GLAND.*

BY CHARLES H. MAYO, M.D.,

OF ROCHESTER, MINN.

A PROBLEM of fundamental importance in the science of medicine, and one, the solution of which would radically change some present indefinite symptomatology, aimlessly directed therapeutics and erroneous records of mortality, is that of the so-termed internal secretions.

Because of this problem's importance in the advancement of medical knowledge, any contribution to the subject, even if it serve no other purpose than to help stimulate a more general practical interest in the question, has a reason for its existence.

In reviewing the rather extensive work which has already been done we find that attention has been focussed mainly upon the following structures: the hypophysis, thyroid, parathyroids, thymus, pancreas, adrenals, testes, ovaries, the lymphatic and the chromaffin system. Whereas the results of investigations prove these to be very important factors in the complex processes, yet evidence indicates and it seems plausible to assume that still other structures of the body are to be considered in this relation. The reported increase of adrenalin in the blood in association with the hepatic affections (Kostlivy), experimental observations on the prostate (Frisch) and the like, are significant in this regard.

In analyzing the results of experimental, clinical, histologic and pathologic investigations which the literature presents, one cannot but be impressed by the frequent lack of uniformity. For some experimenters to have observed practically negligible ill effects from extirpation of one of these organs, while others noted a train of serious disturbances resulting in death, seems

* Read by title before the American Surgical Association, May 31, 1912.

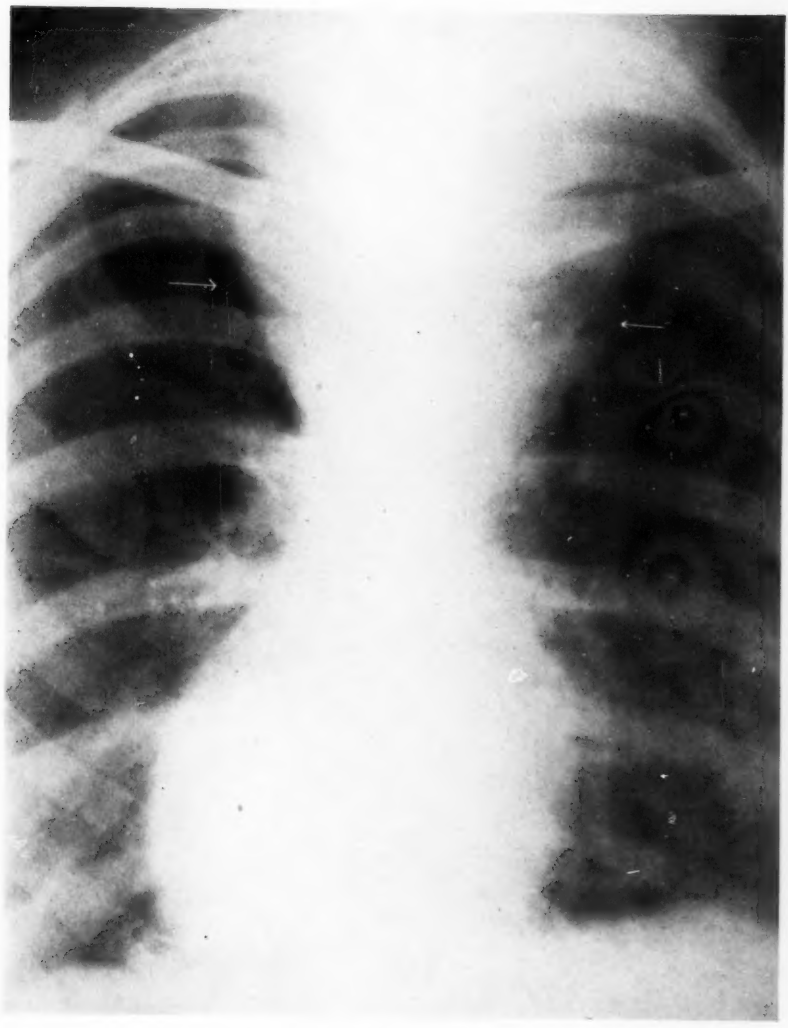
to indicate errors somewhere in the fundamental principles of experimentation. Likewise in the interpretation of the normal in these structures, we see a diversity of views, traceable to a neglect of essential considerations, such as the exclusion of pathologic effects. Hart has pointed out this source of error in the estimation of the thymus, which, he maintains, is commonly affected by the ordinary diseases of childhood. Disturbances, and even death, have been positively ascribed to organs, whose changes might be only compensatory or vicarious, resulting from a correlationship with the true causative factor.

It is obvious, that for accuracy and uniformity of experimental results, parallelism of all the essential factors concerned is a sine qua non. As is commonly appreciated, this parallelism includes animal species, litter, period in the functional life of the organ investigated, functional status of the correlated structures, general conditions, etc. Whereas, a parallelism of some of these factors is more or less readily attainable, yet, it must be admitted that there are others, the determination of which is, at present, fraught with seemingly insurmountable difficulties.

However, despite their evident indefiniteness, the many observations have emphasized one important fact, namely, that in our investigations of these structures their correlationship in physiologic function and pathologic disturbances must be constantly before the mind.

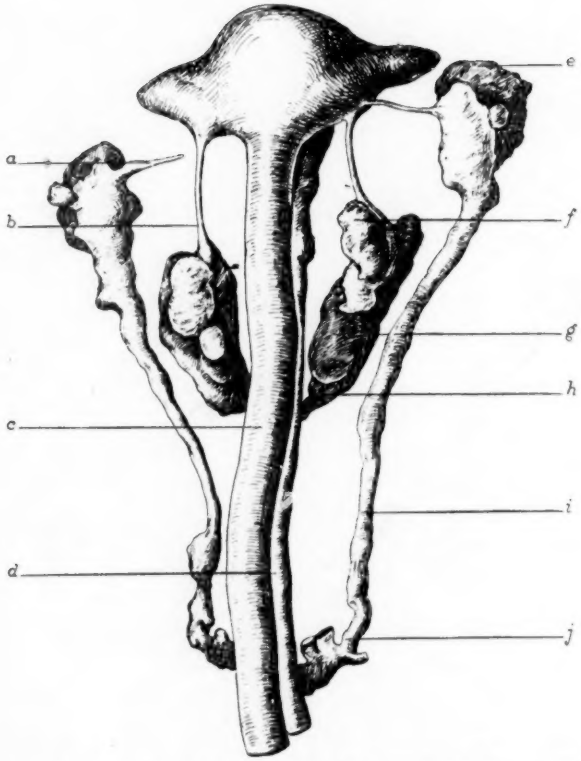
The association of thymic changes with pathologic conditions has long been noted. As early as 1614 Plaster discussed the so-called " thymic death," and reported cases. Since Plaster's time numerous contributions to the subject of the thymus have been made. Of the older works on the subject that of Friedleben (1858)—" The Physiology of the Thymus Gland in Health and Disease from the Standpoint of Experimental Investigation and Clinical Experience "—is one of the most comprehensive. A valuable and exhaustive contribution in recent times is that of Hammar (1909): " Fifty Years of Thymus Investigation." In this " critical review of the nor-

FIG. 1.



Intrathoracic goitre. Confirmed at operation.
Case No. A62264. X-ray No. 14125.

FIG. 4.



Development of thymus and thyroid (from Kollmann's Atlas). *a*, thymopharyngeal duct; *b*, thyropharyngeal duct; *c*, œsophagus; *d*, trachea; *e*, parathymus; *f*, parathyroid; *g*, lateral thyroid; *h*, medial thyroid; *i*, thymus; *j*, thymus.

mal morphology," besides discussing the various morphologic elements in the thymi of different species of animal, including man, Hammar presents a quite complete bibliography of the subject up to the time of writing. This work seems to be viewed as authoritative and Hammar is freely quoted by most writers on the subject. Although agreeing with Hammar in the main, Hart, basing his convictions on the examination of 300 cases, believes that the former has not duly appreciated the thymic changes resulting from the diseases of childhood.

It is impossible to review much of the enormous amount of literature which has been published within the past 300 years upon the thymus and not feel that our knowledge of its function is indeed very limited. At the same time we are impressed in a vague manner with the fact that the gland is very useful, and that it apparently works in harmony with the other ductless glands of the body. Nevertheless, much of the importance attributed to it surgically must be erroneous.

There is a wide divergence of opinion as to the normal size and weight of the thymus. A persistent thymus throughout life is a common condition. It is claimed by some authors that the surgeon should ascertain the size of this gland in all cases before operating for goitre, and, if it be persistent, the operation should not be performed. It is also claimed that an enlarged thymus may be found in all post-operative fatal cases of Graves' disease and, consequently, the gland is always enlarged in this condition. In some of our patients who died from Graves' disease both with and without operation the size of the thymus certainly was not a factor in causing death, since, while persistent in many cases, it was reduced to a vestige in others. It certainly is difficult to differentiate between an enlarged thymus and some substernal goitres (Figs. 1 and 2).

In only one of our cases in which death followed operation for goitre did the thymus appear to be the cause of death. This followed an operation for exophthalmic goitre on a patient forty-eight years of age in whom there was much tracheal stenosis, which was very pronounced during operation, and for

which tracheotomy was indicated. Death occurred one hour after operation. At autopsy the thymus was observed embracing the bifurcation of the trachea, and proved to weigh 56 grams. The ordinary tracheal tube was too short to be effective.

It is probable that the thymus is enlarged more frequently with goitre than with any other condition, yet in the routine work of operating on goitre there seems to be an exceedingly small number of cases in which the persisting thymus presents difficulties. In patients with the thymus so enlarged that the condition can be diagnosed, the effects of operation itself are very rarely fatal, death usually resulting from sepsis or other complications.

It seems probable that some of the reports attributing to "status lymphaticus" the cause of sudden deaths, especially in children, either during or following operation, have been written with a view of distracting attention from the anæsthetic as a factor. Many such instances occur at an age when the thymus should be large normally. In some of the deaths ascribed to "status lymphaticus," in which no great enlargement of the gland was evident at autopsy, it has been taken for granted that there must have been a temporary sudden congestion of the thymus which served the purpose of causing the sudden death and that the enlargement naturally disappeared with this transitory congestion.

The condition "status lymphaticus," as a cause of death, is not to be denied, yet such cases are extremely rare, consequently it is important that, for a better knowledge of the subject, those using the term as applied to sudden death should give the history in detail, all records of the case, likewise the findings at autopsy, in order that the profession may obtain all possible information on this question.

Less than 50 operations have been performed for the removal of the thymus, most of them because of chronic and recurring stridor or dyspnœa. Olivier reports 42 thymectomies with 23 cures. The author states that the operation is an excellent one, since it relieved dyspnœa in 25 out of 28 cases, the

crises of suffocation in 10 out of 12, and the stridor in 12 out of 16. There were 15 deaths in the 42 cases, most of which occurred through sepsis due to the complications of tracheotomy or possibly from difficulties of drainage. Since such complications may occur it is recommended that the operation of thymectomy, which is not difficult, be made before resorting to prolonged treatment by medication or X-ray.

OPERATION.

Technic.—A curved transverse incision, which includes skin and platysma, is made low in the neck. The inner borders of the attachments of the sternomastoid muscles are incised; the sternohyoids are cut across. If the thymus be enlarged, it is seen as a pinkish gland projecting into the neck from behind the sternum, at least during respiration. The gland may now be caught gently with clamps and drawn upon until the fingers can be used for direct traction. The vessels are not large, the fascia which encloses the gland is loose, and there is but little difficulty in clamping and ligating as one lobe is removed. If it be deemed necessary, the second lobe can be elevated and a portion of it removed. In the case operated on in our clinic only one lobe was removed. The relief was immediate and yet there were occasional symptoms of pressure for a number of days. The cure is complete. A drain should not be used unless indications for drainage are urgent. In case it be advisable, a folded strip of rubber tissue should suffice for the few hours during which the procedure may be necessary.

Case I (A56897).—O. T., male, eleven months old. Examination March 8, 1911. Patient has had difficult respiration from birth, as though from obstruction in the windpipe. He turns blue at times and convulsions have occurred several times. Vomiting is frequent. He is unable to sit up, is easier in certain positions with head thrown back. Attacks of coughing with blueness less frequent than formerly. Area of dulness was found over the upper part of sternum extending about 1½ inches to the right and one inch to the left, from the first rib above to the third rib.

Dulness seemed higher on throwing head back—at least a slight change in lowest border. X-ray (Fig. 2) shadow corresponds to dulness. Diagnosis: Enlarged thymus. Operation at St. Mary's Hospital, August 31, 1911. Extirpation of right lobe of the thymus. Gradual improvement followed. March 7, 1912, reports from the patient show that he is developing into a fat, normal child and is learning to walk.

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Plaster: *Loc. cit.*

THE TREATMENT OF SUBCLAVIAN ANEURISM.*

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WITH THE ASSISTANCE OF

JAMES W. JAMESON, M.D.,

AND

JAMES A. CORSCADEN, M.D.,

THE treatment of subclavian aneurism has been so admirably and completely described by Souchon,[15] Savariaud,[13] and Monod and Vanverts,[9] as to render unnecessary further historical or statistical consideration. Of these authors Souchon published in the ANNALS OF SURGERY for 1895 a paper in which all recorded cases prior to that time were arranged in convenient tables and the results of treatment carefully given. Savariaud in 1906 collected 55 instances of operation for this condition published between 1884 and 1904, while Monod and Vanverts in the *Revue de Chirurgie* for 1910 has added those cases appearing in the literature since the publication of Savariaud's paper.

Souchon alone deals with conditions in the pre-antiseptic era and his story is a veritable tragedy. Constant attempts continued over an interval of almost a century to cure this condition invariably proved fatal, and frequently secondary hemorrhage, that most appalling and enervating complication, was the cause of death. In the face of such mortality the surgical courage of these pioneers is all the more surprising in view of the fact that conservative measures occasionally cured. Thus Souchon refers to a series of 35 cases, in which 11 recovered after the use of either Valsalva's method, or direct pressure, massage and kneading, assisted by appropriate diet and rest.

The introduction of aseptic methods largely eradicated the danger of wound infection and by that means diminished

* Read before the American Surgical Association, May 31, 1912.

materially the risk of secondary hemorrhage. In fact this complication occurs at present usually only after ligation of the largest arteries, such as the innominate, and for this reason the ligation of this vessel and others of equal calibre is no longer an operation of choice but of necessity only. The prevalence of this complication after ligation of the large trunks is unquestionably due to the relatively high arterial pressure, and even in pre-antiseptic days this is well demonstrated by its greater frequency after ligation of the right than after ligation of the left subclavian. Thus Souchon states that after ligation in 24 cases of idiopathic aneurism of the left subclavian 12 recovered, while of 17 traumatic aneurisms of the same vessel two deaths only occurred, one after ligation of the second part of the artery from cerebral symptoms and the other from secondary hemorrhage due to the slipping of a ligature. Moreover a study of this complication after ligation of different portions of the right subclavian shows that it is less frequent as the third part of the artery is approached. Thus of the ten cases of ligation of the third part of the right subclavian as well as of the seven cases after ligation of the second part, in the combined statistics of Savariaud and Monod and Vanverts, no case of secondary hemorrhage occurred, while in the 17 cases of ligation of the first part collected by the same authors, two deaths from secondary hemorrhage are noted, while after ligation of the innominate during this same period no less than one-third died from this post-operative complication. It is quite clear then that, in spite of asepsis and the improved methods of ligature application, the possibility of secondary hemorrhage after ligation of the largest trunks still persists, and therefore in presenting the report of a case of successful ligation of the first part of the right subclavian, the writer feels justified in discussing whether after ligation at this particular point, at least, there may not be some practical means by which the occurrence of this much dreaded complication may be eliminated. At the same time the different methods of treatment of this particular variety of aneurism—that of the third part of the subclavian artery—will be briefly described.

Aneurisms of the subclavian artery are most frequently found in the first or third portion. According to their relation to the scalenus anticus they are sometimes spoken of as extra- and intrascalenic respectively. The second part of the artery placed between the powerful and constantly contracting scalenus anticus and medius is so firmly supported by those structures that primary aneurism rarely if ever occurs, and secondary aneurism develops only occasionally from the extension of a primary aneurism in either the first or third portion.

Before proceeding to the discussion of the operative treatment of this condition, the writer wishes to call attention again to the fact that medical measures, according to the investigation of Souchon, have proved successful in 11 of 35 cases, and that in slowly-growing aneurisms of small or moderate size, such conservative treatment is indicated. The report of the following case is cited to justify this statement.

Mr. F., age sixty-two, referred by Dr. Runyon in 1906. Patient, who has always enjoyed good health and without the slightest suspicion of a specific lesion, accidentally discovered several weeks ago a small pulsating tumor above the inner part of the right clavicle. On examination this tumor proved to be an aneurism extending as far outward as the external jugular vein. From its position it evidently involved the first part of the right subclavian, and would require, in the event of its increasing in size, the distal ligature of the artery. Before this was attempted the patient was treated by rest and diet, and the aneurism perceptibly decreased in size, although it did not entirely disappear. At the present time the patient's condition is quite satisfactory.

Owing to the rarity of aneurism in its second portion, the consideration of the operative treatment of subclavian aneurism is practically limited to aneurisms occurring in the first and third portions of the artery. Aneurisms in the first part of the artery are rarely if ever so situated as to permit of any other form of proximal ligation than that of the innominate. This operation is so frequently followed by secondary hemorrhage, not to mention the danger of a fatal cerebral anæmia,

that, as has already been mentioned, it has ceased to be an operation of choice.

Thus Savariaud has collected 12 instances of ligation of the innominate between 1884 and 1906. In this interval no ligation of choice has been attempted since 1895, subsequent to which year two ligations "from necessity" have been done, one by Symonds in 1899 with success for uncontrollable hemorrhage in the course of a ligation of the first part of the subclavian (the common carotid also tied), and the other by Moynihan in 1897 for secondary hemorrhage after primary ligation of the subclavian, the patient dying (this case was complicated with sepsis). Of the remaining 10, two were of traumatic origin in young subjects and of these the case reported Twynam (1890) died from cerebral anæmia 18 hours after the operation, while Lemtas in 1889 reported a recovery. Of the remaining eight, no detailed account of the history of the patient operated on by Willet is given; two recovered, namely Coppinger's case in 1893, in which the common carotid was also tied, the patient being well two and one-half years after the operation, while Durande's patient was lost sight of ten days after the operation. A patient operated on by Burrell lived for 104 days and then died from myocarditis and its complications. In this case, the artery was tied with a double ligature of silk, and at the autopsy it was found that the lower of the two ligatures had cut through the wall of the artery, with a restoration of its lumen. Three patients died from secondary hemorrhage on the nineteenth (May, 1886), thirty-third (Bull, 1884), and thirty-seventh days (Banks, 1885) respectively. One patient (Helferich, 1887) died from cerebral embolus two days after the operation. Beside the innominate in these various cases, the carotid was tied five times, the vertebral once, the carotid and the vertebral twice, and the carotid and subclavian twice.

That ligation of the innominate should have been discarded as a matter of choice is more than justified by the successful results achieved by distal ligation for aneurisms of the innominate or the first part of the subclavian or of both. Of distal ligation for aneurism of the first part of the subclavian Savariaud has collected nine cases without a death. In four of these in which the common carotid was tied as well, three were completely cured.

In Lloyd's case, the tumor decreased in size and became harder; in Monod's case, the tumor disappeared completely although the pressure paralysis persisted; in Gerard-Marchant's case, the aneurism which had resisted treatment by gelatine injection was completely cured. In the remaining cases, the reported improvement or cure of the aneurism cannot be definitely ascribed to the ligation, as in two cases, those reported by Braun and Carmini, the aneurism was treated simultaneously with electrolysis. Braun's patient was well at the end of two years, while

Carmini's, after temporary improvement, died five months after the ligation from a rupture of the aneurism. In two cases reported by Barkley and Meriwether the result is described as satisfactory. From a consideration of these cases, Savariaud recommends the distal ligation of the third part for aneurism of the first portion of the subclavian, with ligation of the common carotid as well, should the innominate be dilated. In Monod's case the carotid was tied because in some unexplainable way its compression diminished the aneurismal pulsation.

The treatment of aneurisms of the third part of the subclavian by ligation differs essentially from the first portion in that the ligation may be either proximal, distal, or both. Of proximal ligation Savariaud has collected nine cases with two deaths from secondary hemorrhage.

In one case, that of Kammerer,[5] the patient died three weeks after operation, and an autopsy showed the catgut ligature had in one place cut through the arterial wall. In Pitt's case, the hemorrhage occurred several weeks after operation, also at the point of ligature. In both, this complication occurred without wound infection.

The occurrence of secondary hemorrhage in these two cases cannot be taken as a fair criterion of the danger of this complication after ligation of the first part of the right subclavian, for in Kammerer's case the aneurism developed in a syphilitic subject and in Pitt's case the aneurism, complicated by a cardiac lesion, had involved both the second and third parts of the artery. In both cases it is probable that the strength of the arterial wall at the point of ligation had been seriously impaired by the co-existing endarteritis. Had the aneurism resulted from trauma or had it attacked the artery of a patient otherwise healthy, secondary hemorrhage would probably have not taken place. In the statistics of Monod-Vanverts, the first part of the right subclavian artery was ligated in eight different patients without any case of secondary hemorrhage.

An interesting secondary complication in connection with ligation of the first part of the right subclavian artery is the frequency of relapse. Of these Savariaud reports three and Monod-Vanverts two, altogether five in a series of 19 cases.

In Clutton's[8] case (1897) the aneurism, the size of a gall-stone, involved the third part of the artery. In the first operation a single ligature

of gold-beaters skin (to which Clutton ascribes the recurrence) was placed around the artery on the distal side of the thyroid axis and internal mammary. The pulsation rapidly returned. In the second operation three months later a ligature of silk was placed around the artery to the proximal side of these same branches, which were also ligated individually with silk as well. There was no sign or trace of the original ligature and the lumen of the artery had been completely restored. Seven days later a ligature of the axillary first diminished and shortly after brought the recurrent pulsation to a standstill. In this case the first ligature had temporarily at least occluded the main vessel, during which time the collateral circulation had become thoroughly established. The second ligature permanently occluded the main vessel and abolished the direct current of blood, but the pulsation did not disappear until the collateral circulation was effectively cut off from the aneurismal sac by ligation of the axillary.

In Lediard's[9] case the aneurism involved the third part of the subclavian and was as large as a duck's egg. Here also three operations were performed, the ligation of the first part of the subclavian, the axillary, and finally the excision of the aneurismal sac after resection of the clavicle. The aneurism contained no clot but only atheromatous patches.

In Allingham's[1] case the aneurism extended from the sternomastoid to the trapezius. Three days after the ligation of the first part of the right subclavian at the inner margin of the scalenus anticus, the pulsation recurred and in four weeks the aneurism had regained its former size. The clavicle was then resected, the axillary ligated, and the aneurismal sac excised. In the dissection of the sac from the brachial plexus, the adherent subclavian vein had to be ligated and the second part of the subclavian and the transverse coli were also tied. The aneurism was filled with firm clots and the lumen of the subclavian artery was not completely obliterated.

In the two relapses mentioned in the table of Monod-Vanverts, a cure was effected by distal ligation of the axillary.

Of the ten cures, four collected by Savariaud are said to have been complete (Schumfert,[14] reported nine weeks after; Halstead, reported six weeks after; Tuffier,[16] reported one year after; and Kraske reported nine months after). Of the six cures collected by Monod-Vanverts, four were incompletely relieved, as follows: in one, paralysis of the upper extremity persisted; in a second pain still continued eight months after the operation; in a third the circulation of the upper extremity, four months after, was described as bad, and in a fourth there was some motor trouble.

Aneurism of the first portion of the subclavian is rarely so placed as to permit proximal ligation of that part of the artery. Savariaud has collected nine cases in which such a ligation was practised, with one death (reported by Braun) due to cerebral embolus 22 days after operation—a rare complica-

tion under any circumstances. Of the recoveries one patient died subsequently from a rupture of an aneurism of the arch. Another patient remained in good health at the end of four years, and of the others the aneurism was cured but either local paralyses or trophic disturbances persisted indefinitely. In general the end results are described as satisfactory.

Savariaud also mentions four instances of proximal ligation of the second part of the subclavian, all of which recovered from the operation. In two cases of traumatic origin the ligation cured the aneurism. In a third of idiopathic origin (reported by Godler) the patient shortly after developed aneurism of the arch of the aorta.

While proximal ligation of the subclavian wherever it can successfully be carried out seems preferable to distal ligation of either that vessel or axillary, the latter procedure has proved its value as a secondary measure in cases where proximal ligation has been followed by a relapse of the aneurism. Several instances, notably Clutton's,[3] have previously been mentioned in which a cure was effected by this means.

A summary of the tables compiled by Savariaud and Monod-Vanverts shows that ligation of the third part of the subclavian is practically without mortality while ligation of the first part of the right subclavian is occasionally followed by secondary hemorrhage. While in pre-antiseptic days this complication not uncommonly resulted from wound infection, the possibility of its recurrence must still be recognized even where suppuration is absent, especially in the ligation of the large trunks near the heart, in which category the first part of the right subclavian must be included. Measures to prevent this complication must logically provide for the formation of a clot of sufficient extent to permanently and effectively seal the artery at the point of ligation, at which point subsequent examination in the cases of Kammerer [5] and Pitts showed the hemorrhage to have taken place. Even in Burrell's [2] case an autopsy showed a partial division of the arterial wall by the ligature with restoration of its lumen. The well-known fact that a clot, after ligation of an artery, is longer the greater the

distance between the nearest branches on either side of the point of ligation, has established the advisability of applying a ligature in continuity at a point as remote as possible from any considerable sized branch. In the first part of the right subclavian, however, the proximity of large sized branches makes it difficult to satisfactorily observe this principle, and under these conditions as well as in accidental division of any large vessel near an important branch, the formation of a satisfactory clot is provided not only by the ligation of both ends of the divided artery but by the ligation of any adjacent branches as well. The writer does not wish to imply that the entire brunt of withstanding the high arterial pressure is placed upon the clot alone. The reparative tissue adjacent and superficial to the divided artery shares this burden, and yet, although this is quite true, the fact that the interior clot formation bears the larger share is demonstrated by the fact that fatal secondary hemorrhage after ligation of the innominate has taken place through a healed operative incision. In the case herewith reported the writer tied all the branches of the first part of the right subclavian with the exception of the vertebral, with the object not only of diminishing the risk of secondary hemorrhage, but also by constricting the flow of blood through the aneurismal sac by way of the collateral circulation to diminish the risk of recurrence. In order to still further ensure success, the transversalis coli and the supracapsular were ligated a second time as they crossed the scalenus anticus.

The risk of secondary hemorrhage is still further lessened by the number of type of ligature. Two ligatures should be applied, separated by an interval of from a quarter to a third of an inch, of which the proximal should be tied with sufficient force to oppose the intima and the distal ligature should be tied as tightly as possible. For the proximal, silk or a Halstead ring is used, for the distal, chromic gut. While the writer recognizes the excellent results achieved by the Ballance-Edmunds knot, yet in an artery near the heart it is not inconceivable that this method, as in the case of Clutton, might result in a yielding of the ligatures and the restoration of the

lumen of the artery with subsequent recurrence of the aneurism. In this situation the writer is an advocate of the method suggested. The distal ligature (still on the proximal side of the aneurism) ruptures the intima and the resulting clot, beginning at this point, rapidly forms behind the friendly shelter of the proximal ligature and subsequently probably extends beyond it to the vertebral.

The repair of arteries after ligation is an interesting study and in order to investigate this question as well as to determine the danger of secondary hemorrhage after the ligation of large arteries near main trunks, the following experimental work was conducted under my supervision by my assistants Drs. Jameson and Corscaden. The internal iliac of the cat just below the point of division of the common iliac was selected and the following ligations were performed:

1. Ligation of the internal iliac artery with No. 2 plain gut one-eighth inch from the bifurcation of the common iliac. Vessel cut. Examination about four months afterward showed the ligature still in place and a slight dimpling of the artery at its point of origin. Microscopic examination showed extensive connective-tissue formation at the point of ligature.

2. The above operation repeated. Examination four months afterward showed the proximal part of the artery converted into a mass of connective tissue with the same slight dimpling at its origin.

3. Same operation as above with application of ligature one-sixteenth inch from bifurcation of common iliac. Animal killed two weeks later on account of distemper. Autopsy showed no sign of hemorrhage nor clot. The ligature was still in place and there was a slight dimpling of the artery at its point of origin.

4. Ligation of internal iliac artery in continuity with fine silk one-quarter inch from bifurcation. Examination three months later showed ligature imbedded in connective tissue. Distal to ligature the artery was converted into a thin cord as far as the first branch.

5. The same operation as in 4 repeated with the same result at the time of examination two months later. Microscopic examination showed only connective tissue.

GENERAL CONCLUSIONS.

In these cases the vessel proximal to the ligature was obliterated and converted into a fibrous cord, only a slight dimpling in the wall of the artery persisting at its point of origin.

Distal to the ligature the lumen was obliterated and the vessel was converted into a thin fibrous cord extending as far as the first branch in those vessels ligated in continuity, but in the other cases only a small mass of connective tissue could be recognized.

At the point of ligation fibrous tissue surrounded the artery and the silk ligatures were imbedded and covered in by this new tissue. In none of these cases was there secondary hemorrhage.

Although the treatment of subclavian aneurism by the different ligations which have just been discussed is of classic origin, it must not be forgotten that other methods of treatment have given satisfactory results. Of these the operation of Antyllus and its modification, in which the sac is excised after ligation of the afferent and efferent trunks, are the most conspicuous. The former is especially effective in traumatic aneurisms of recent formation, for in this group the sac is not well-defined and excision is unnecessary and might even be impracticable. On the other hand excision of the sac, even though formed in part by the clavicle, is indicated in all pathological aneurisms as a secondary measure where, notwithstanding both proximal and distal ligation, the aneurism persists. The history of cases treated in this manner shows that the separation of an old sac from the subclavian vein as well as from the branches of the brachial plexus may be quite difficult and that occasionally the sacrifice of the vein cannot be avoided. Under these conditions the exposure and dissection of the aneurismal sac, frequently in old cases a difficult matter, as well as the proximal and distal ligation of the artery, are greatly facilitated by a resection of the overlying clavicle. Such a resection does not materially weaken the function of the shoulder and is always indicated when the clavicle forms a part of the aneurismal wall as well as in uncomplicated ligation of the first part of the right subclavian with or without the additional ligation of its branches.

In the excision of aneurisms of the large arterial trunks the writer wishes to call attention to the fact that the division of the overlying tissues, through a withdrawal of its accustomed

support, subjects the aneurismal wall to a sudden increase in pressure and thereby predisposes to its rupture. Although the writer has found no mention of this accident in the literature, yet in personal communications he has learned of several such unfortunate experiences. The corollary is obvious, namely, that this danger is to be avoided by excision of the sac only after ligation of the arterial trunk on both its proximal and distal sides.

The danger of secondary gangrene of the extremity seems to be comparatively *nil* after either ligation or excision. This is in accordance with the general observation that gangrene is more common the greater the distance from the heart at which the main arterial trunk is ligated.

Of aneurisms of the subclavian treated by excision Savariaud cites two of the traumatic variety treated with success by the method of Antyllus (Miles, 1893, and Taylor, 1903) and seven other cases of excision proper, including a case of his own. Of these two excisions, those of Allingham [1] and Lediard [6] were practised only after failure of both proximal and distal ligation. In a third (Schumfert), the aneurism had reached such a stage of spontaneous cure that it was mistaken for a solid tumor. Of the seven cases, one death occurred, that in Moynihan's [10] patient on the fifty-ninth day from secondary hemorrhage. An autopsy showed that the hemorrhage resulted from the rupture of a new aneurism nearer the heart. In the case of Tuffier,[16] excision was attempted, but owing to the intimate adhesions between the vein, the branches of the brachial plexus, the clavicle, and the sac, the operation could not be completed. This case, previously cited, was well at the end of a year. Savariaud's table does not include the case of Halstead,[4] of Chicago (1892), cited by Souchon, in which an aneurism of the left subclavian was excised together with the overlying clavicle and adherent vein in one piece after ligation of the first part of the subclavian as it emerges from the chest. This patient made an excellent recovery, and was the first successful result of ligation of the first part of the subclavian for aneurism.

Although with very few exceptions the operative treatment

of subclavian aneurism has consisted in some form of ligation of the artery or of excision of the sac, there are in the literature several instances in which endoaneurismorrhaphy—the operation of Matas—has been attempted. Ordinarily this operation requires effective hæmostasis and is therefore especially adapted to the treatment of aneurisms of the extremities in which this desideratum can be well supplied by the application of an Esmarch bandage. In subclavian aneurism complete hæmostasis is possible only after preliminary ligation of both the proximal and distal arterial trunks, and to conform to the principles of the Matas operation these ligatures must be so applied that, on the completion of the closure of the sac, they can be removed and the normal lumen of the artery be restored. To fulfil this condition the Halstead bands are less likely to damage the intima than any ligature of silk or gut. That both proximal and distal ligation are necessary is well demonstrated in the following cases:

Lilienthal[7] applied a temporary ligature of chromic gut about the first part of the right subclavian half an inch from its origin with sufficient snugness to obliterate aneurismal pulsation. After being emptied by compression, the aneurism refilled slowly and continued to refill although more slowly after a similar temporary ligature of the carotid. The sac was then incised and a column or blood welled up four inches in height and was controlled by digital pressure. The subclavian was then tied at the point of the temporary ligature with a Ballance-Edmunds knot and the carotid permanently tied and the incision in the sac closed with catgut. Three months afterward a small hard mass only could be felt, and although no pulsation could be detected in the radial, the circulation in the extremity was satisfactory.

Pringle[12] placed a clamp on the proximal side of the aneurism and a loop of strong silk on its distal side to obliterate by traction the lumen of the vessel at that point. On opening the sac, the hemorrhage was so free that it could be controlled only by a clamp on the distal side as well. The sac was then sutured with fine silk and the clamps removed. No bleeding took place.

Lozano[8] tied the first part of the right subclavian within the scalenus. On incising the sac there was free hemorrhage which was checked by ligation of the superior intercostal and the internal mammary. The aneurismal sac was then obliterated by endoaneurismorrhaphy. Recovery followed. The radial pulse could be felt six hours after the operation.

E. D. Martin and F. W. Parham[11] tied the first part of the right

subclavian after resection of the inner three-fourths of the clavicle for fusiform aneurism of the second and third parts of the artery. On incising the sac, violent hemorrhage took place and was checked only by ligature of the opening leading into the sac as well as of that leading into the artery beyond. A cure was the result.

To complete the series of cases of endoaneurismorrhaphy for subclavian aneurism the case of Munro cited by Matas, in which the mere statement of the fact that a cure resulted, may be mentioned.

The great advantages of the Matas obliterating operation in general are that it almost always permanently cures the aneurism, that the risk of secondary hemorrhage is very slight, that gangrene of the affected vessel is rare, and that the mortality of the operation is negligible. Thus, in the latest statistics gathered by Monod-Vanverts, of 103 cases there were 89 cures (of 149 reported by Matas there were 133 cures). Relapse occurred in 1.5 per cent. Secondary hemorrhage occurred once in 63 cases of the obliterating operation and only twice in 23 cases of restorative aneurysmorrhaphy. Gangrene was observed in from 3 to 5 per cent. and there was a mortality for which the operation was directly responsible of 3 per cent.

Equally good results are shown by the same authors in an analysis of 205 cases, to have been achieved by excision. Of these 90 per cent. were cured. One and one-half per cent. relapsed. There was a mortality of 3 per cent. and although, theoretically, the dissection of the sac must sacrifice many vessels, on the conservation of which the establishment of an adequate collateral circulation may depend, there was only 4 per cent. of gangrene.

On the other hand analysis of 138 cases of the different forms of ligation by the same authors showed 74 per cent. cures, 12 per cent. relapses, six and one-half per cent. gangrene and a mortality of 7 per cent.

The inference is obvious that considering the subject as a whole, obliterating endo-aneurysmorrhaphy and the treatment of aneurism by excision are of equal merit and superior in every way to ligation. That on the other hand, restricting the discussion to the treatment of subclavian aneurism only, the inferiority of ligation is not so apparent, chiefly because

of the lack of a sufficient number of cases in which the Matas operation has been attempted in aneurism of this variety. At the same time it is interesting to note that such astute observers as Monod and Vanverts do not believe the Matas operation to be suitable for subclavian aneurism or for those at the base of the neck.

The same paucity of cases of subclavian aneurism treated by the Matas method makes it difficult to reach any just conclusion regarding the comparative value of this procedure judging by the character of the end-results. Even in the more frequent aneurisms of other arteries Monod and Vanverts state that, while the cure or failure is recorded, any mention of subsequent disturbance of the circulation, other than gangrene, is rarely given. Probably more detailed information would show that, while the aneurism proper had been cured, some impairment of the circulation had led more or less permanent motor, trophic, or sensory disturbances, and that the utility of the extremity had been correspondingly affected. Certainly it has been conclusively shown that disturbances of this character have not infrequently persisted after the treatment of subclavian aneurism by both ligation and excision. On the whole the writer shares the opinion of Monod and Vanverts that the results of the treatment of subclavian aneurism by ligation or excision are not inferior to those which might be obtained by the Matas method.

In conclusion it may be stated that the most satisfactory treatment in aneurism of the third part of the right subclavian (or of either subclavian) is a ligation of the first part of this artery together with its branches, with the possible exception of the vertebral; that such simultaneous ligation of the branches diminishes both the risk of secondary hemorrhage and the possibility of subsequent relapse of the aneurism; that, in the event of a recurrence, a cure may be effected by distal ligation of the axillary as close to the aneurismal sac as possible; should the aneurism again recur, excision of the aneurismal sac after the ligation of the main arteries supplying it should be attempted; that these various operations are facilitated by

a preliminary resection of the clavicle and if necessary of a portion of the manubrium as well; that in many cases a cure of the aneurism is marred by some permanent disturbance of the extremity, either motor, sensory, or trophic; that unfortunately these patients are prone to the subsequent development of a fatal aneurism of the aorta.

L. C., male, age fifty-three. Gas-fitter, admitted to the Presbyterian Hospital November 26, 1910. Referred by Dr. James Law. Patient gives a history of the excessive use of tobacco and alcohol. Twenty-four years ago patient had urethritis and states that he had a chancre. Apart from this, there is no definite history of syphilis. Patient at different times has suffered moderately from chronic rheumatism.

Eight months prior to admission to the hospital patient first noticed pain and parathesia in the right arm. There was also burning pain in the right scapular region. He was treated for rheumatism in one of the dispensaries of this city. One month later patient noticed for the first time a swelling in the right suprascapular region. The pain in the right arm had continued and was sufficiently severe to confine the patient in bed for five weeks.

On admission examination revealed a swelling having expansile pulsation in the right suprascapular region the size of a large orange, extending as far forward as the posterior border of the sternomastoid and backward to within several inches of the point of the shoulder. The tumor could not be seen in the axilla but on palpation it could be easily mapped out between the finger in the apex of the axilla and the other hand above the clavicle. There was a distinct thrill, a systolic murmur, and a diastolic shock. The expansile pulsation was synchronous with the heart beat and the cardiac second sound was accentuated and high-pitched. The murmur over the aneurism was transmitted for a short distance up the carotid but a longer distance down the axillary. The radial pulses were symmetrical and the arterial tension in this artery was somewhat higher than normal.

The patient was placed in bed with restricted diet, and at the end of three weeks the blood-pressure had materially decreased and the pulse was slower. The aneurism proper showed no improvement, and therefore operation seemed advisable.

Operation (December 12, 1910).—Under gas and ether anæs-

thesia the first part of the subclavian artery was exposed through the usual V-shaped incision at the inner part of the clavicle, the sternomastoid, the sternothyroid, and sternohyoid being divided and the inner extremity of the clavicle removed. The common carotid was first exposed together with the internal jugular vein and the pneumogastric nerve. A temporary ligature placed around the carotid did not affect in any way the aneurismal pulsation. The subclavian artery in its first part was then exposed, and the interesting fact was noted that although both the internal jugular vein and the pneumogastric nerve are on a decidedly posterior level to the carotid artery, they crossed the first part of the subclavian without any angle whatever. If the subclavian and carotid were given off in the same lateral plane from the innominate, the above-mentioned structures would naturally cross the subclavian at an angle. The fact is, however, that the innominate divides in such a way that the subclavian lies much behind the level of the carotid. This is of importance in accounting for the unusual depth at which the artery lies. As the dissection was continued, the phrenic nerve, crossing the artery obliquely from without inward, was exposed and held to one side. The sympathetic nerve was also recognized and avoided. No structure resembling the right lymphatic duct was seen. The branches of the subclavian were then exposed and tied with chromic gut. A silk ligature was then placed around the artery near its origin and tied so as to snugly oppose the intima while a second ligature of chromic gut was placed about one-third of an inch on the distal side of the silk ligature and, like the ligatures around the branches, was tied as tightly as possible.

Aneurismal pulsation immediately ceased after the application of the first ligature. Before the closure of the wound the suprascapular and transversalis coli vessels were also tied in front of the scalenus anticus. The divided muscles were then sutured, and the skin closed in the usual way. The patient did not suffer in the least from the operation and healed primarily. Twenty-four hours after the operation a slight flicker was felt in the radial artery and the slightest possible pulsation was felt for a few hours in the aneurismal sac. The arm felt slightly numb. At no time was there any thrill over the aneurismal sac.

Four days after the operation, the radial pulse, though feeble, could be distinctly felt. There was no longer any pulsation in

the aneurism, but a faint murmur could be distinctly heard, although the source of the murmur was questionable and it was thought that it might be due to a roughening of the aortic valve.

Ten days after the operation the right radial pulse was ten beats less frequent to the minute than the left radial pulse, and this difference has persisted ever since. The aneurismal sac is becoming firmer and evidently beginning to consolidate. One month after the operation, the aneurism had greatly decreased in size and only a hard firm mass the size of a golf ball remained. From this time on as further shrinkage took place, the supra-scapular fossa began to be drawn in.

Seven weeks after the operation the patient was allowed to begin to walk and shortly after left the hospital. At that time all ordinary movements of the arm were permitted with the exception of abduction. Ten months later, as the patient returned to work, this motion also was allowed, and notwithstanding the resection of the inner part of the clavicle could be carried out almost as well as on the opposite side. At the present time the patient is in very satisfactory condition and able to earn his living as a gas-fitter. During the past winter during the very cold weather he states that it was more difficult to keep the right arm warm than it was the left. This seems to be the only manifestation of the decreased circulation in the extremity.

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ON DRAINAGE AFTER INTRATHORACIC OPERATIONS WITH SPECIAL REFERENCE TO THE ŒSOPHAGUS.*

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THE effect on the pleura of mechanical irritation, as it occurs in the course of intrathoracic operative work, is different from that upon the peritoneum. Whereas the latter usually answers with the formation of adhesions, the pleura frequently throws out an exudate, which, within a very short time, fills more or less the entire pleural cavity.

It may be worth while to mention right here that this exudate is found only when the lung as such has been left in place. It is not found after aseptic pneumectomy. If one pleural cavity of a dog has suddenly been deprived of its contents, not fluid but air will fill the cavity. We have found this in all our total extirpations of one lung, an observation which suggests the thought that the pulmonary pleura may be principally responsible for the exudate.

If the fluid is sterile and remains sterile, gradual absorption is the rule. If it is infected, it needs exit, and the sooner the better. When sterile, the color of the fluid is that of ordinary serum, clear and yellowish; when infected, it is turbid and serosanguinolent. Aspiration of the exudate, done with the help of Potain's or Dieulafoy's apparatus, is of no avail, as it reaccumulates in a short time.

Another occurrence to be reckoned with is the entrance of air into the closed pleural cavity. In the event of an injury to the lung, for instance, there is likely to follow a steady escape of air into the pleural cavity, which, in turn, would cause the most dreaded and deadly of all complications, the

*Read before the American Surgical Association, May 31, 1912.

so-called "pressure pneumothorax." Suture of the lung cannot always prevent it; sometimes the very stitches placed to close the injury produce new leakage, and in instances of severe injury the wound cannot be closed at all.

Danger of air entering the pleural cavity exists also in connection with operations upon the œsophagus, when followed by air-tight closure of the thorax. The human œsophagus is extremely thin, its muscular coat very friable; stitches tear out easily. In the endeavor to make them hold, one is apt to penetrate into the lumen. The suction-cup effect of the closed pleural cavity—there being negative pressure in the latter and atmospheric pressure within the œsophagus—will then with each inspiration aspirate air through the penetrating stitch-holes. The result is a combination of infected serosanguinolent fluid effusion with pressure pneumothorax, followed by sudden death.

In view of such experiences and the not unfrequent occurrence of acute infection of the pleural cavity, in spite of most careful asepsis,[1] it was but natural that surgeons bethought themselves of drainage.

However, drainage had its difficulties. If applied in accordance with generally accepted surgical principles, it was sure to develop a post-operative acute pneumothorax and besides thereby greatly to increase the chance of infection of the pleural cavity. These dangers have prompted surgeons to close the thoracic wound air- and water-tight, thus giving this class

[1] It is not impossible that old adhesions within the pleural cavity harbor encapsulated microbes. Recently, when a branch of the pulmonary artery had been tied for bronchiectasis, the case became infected, necessitating reopening of the wound after 48 hours; in the preceding case of the same kind the wound had healed primarily, with the trouble soon greatly improved. Equal care had been given to asepsis in both cases. Hence the thought presented itself, whether the old adhesions, binding pulmonary pleura to the costal, or to the pericardium or diaphragm, especially shortly after inflammatory intrapulmonary processes, might not be the quiet resting place of microbes. They could become active and virulent in the presence of exudated blood. Investigations in conjunction with the serological department of the German Hospital are now in progress at that institution.

of cases an exceptional position, also as regards the after-treatment.[2]

To overcome the post-operative acute pneumothorax, therefore, was the task that needed solution.

Within the last two years a number of attempts have been made in this direction. In 1910 Wendel [3] conceived the idea of splitting the diaphragm when operating for cancer of the cardia and at the close of the operation stitch it on to the œsophagus in such a way as to place the field of operation intra-abdominally, so that drainage could be accomplished through the abdomen. This method has been tried but once in the human being by Sauerbruch. The result he obtained, as far as the division and subsequent suture of the diaphragm is concerned, was satisfactory.

Last year, Tiegel constructed a flexible metal drainage tube with a rubber valve [4] (see Fig. 1). It is placed in one angle of the wound, or introduced through a special opening, and forms a part of the dressing. He tried it in one case, in which it worked to his entire satisfaction. A few weeks ago, before the last meeting of the German Congress of Surgeons at Berlin, Tiegel stated [5] that he had used his valve-drain in several cases with good results.

In the fall of 1909, when planning the new pavilion for thoracic surgery at the German Hospital, it occurred to us that the post-operative acute pneumothorax resulting from intrathoracic drainage could be avoided by leaving the patient under differential pressure for some time after operation. Later, upon trial, with a nurse or doctor enclosed in the cabinet with the patient's head and one or two attendants outside, the plan proved feasible. The air-lock of the cabinet permits an exchange of persons inside, also the carrying

[2] The attempts to close off certain parts of the pleural cavity by draining with strips of gauze soaked in Lugol's solution have not been very encouraging.

[3] Langenbeck's Arch., vol. 93, p. 311.

[4] Centralbl. f. Chir., 1911, No. 10.

[5] Berl. klin. Wochenchrift, April 29, 1912, p. 867.

to the patient of whatever refreshing liquids, etc., it may be thought wise to let him have or rinse his mouth with.

Rectal drop instillation and hypodermoclysis, intravenous injections and hypodermic stimulations, practically all that is required within the first 24 hours, at least in the more serious cases, is done outside; also the feeding of the patient through the gastric fistula, which had been primarily established in cases of œsophageal resection. The necessity of having two or three persons attend the patient is somewhat cumbersome. The splendid spirit shown by the house staff as well as nurses of the German Hospital has been most gratifying. In fact, when we drained our first case in this way in May, 1911, many more doctors and nurses than were required volunteered to do the work. However, to lighten the burden of our school nurses, we have of late engaged "specials" to take charge of these patients for the first 24–48 hours. In time we hope to have also a special, trained crew of doctors for this class of cases.

In October, 1911, Green and Janeway[6] advocated drainage of the pleural cavity for the purpose of overcoming the frequently forming exudate after œsophageal resection for experimental surgery. They proposed leaving the animal with such drainage under differential pressure for 24–48 hours; then (after 24 hours) establishing permanent irrigation with a double cannula up to the place of the anastomosis, meanwhile continuing differential pressure for a short time; removal of drainage on the following day. Up to the time of their publication, the plan had not been tried.

Any differential pressure apparatus, the use of which does not require general anæsthesia, may be employed for the purpose.

Perthes' suction apparatus for the treatment of empyema might probably also be used to advantage, as well as, in special cases, a Bier's suction cup (Tiegel).

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[6] ANNALS OF SURGERY, vol. liv, October, p. 549.

The details of the method so far worked out by us at the German Hospital are as follows:

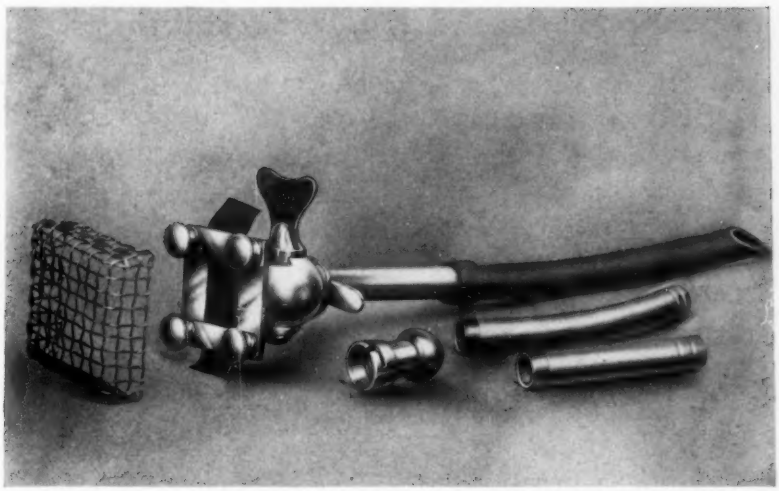
In aseptic cases the wound is closed entirely without drainage and the patient returned to the ward. If drainage appears indicated, an additional incision is made in the complementary space, usually in the ninth or tenth intercostal space, in the scapular line, and one or two drainage tubes are inserted; the original incision is closed. In other words, the same technic as that employed within the abdominal cavity or other parts of the body is followed. Ordinary rubber drainage tubes, split along their longitudinal axis—we call them gutters—are in great favor with us. In resection of the œsophagus, the œsophageal bed in the posterior mediastinum is filled with a long cigarette drain, carrying a central, unsplit rubber tube, and an additional short gutter is introduced on either side of same. The use of the cigarette drain alone has not been found reliable according to our experience; it sometimes acts as a stopper rather than a drain, especially if but a short intercostal stab was made, such as it is customary to make in the abdominal cavity. It is not advisable, however, when draining the thorax, to use short incisions, since in view of the extreme narrowness of the interspaces the ribs are apt to compress the drain. Thereupon a partially divided piece of gauze is pushed under the safety-pins, which secure the drainage tubes, and a large piece of sterile rubber dam is put on top;[7] a voluminous gauze dressing which includes the arm finishes the dressing. Now the patient is transferred to the after-treatment bed, which is without headpiece[8] (Fig. 2), and wheeled to the positive pressure cabinet. He thus rests in bed comfortably, just as other patients, the only difference being that his head is inside the apparatus (see Fig. 3).

Had the operation been done in the negative chamber and

[7] In future cases it is intended to cover the skin of the immediate neighborhood of this wound with zinc ointment (Sauerbruch) so as to insure still better adhesion of the borders of the piece of rubber dam all around the wound.

[8] Medical Record, June 17, 1911.

FIG. 1.

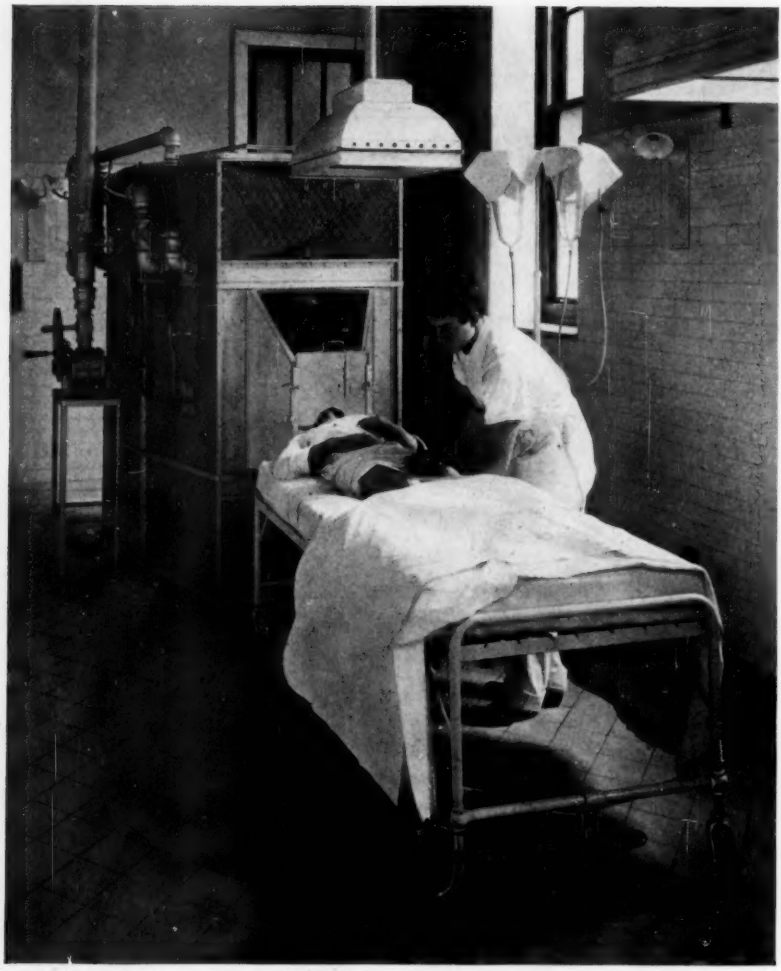


Tiegel's thoracic flexible metal drain. The tube that passes the thoracic wall can be properly bent to correspond with the contours of the posterior thoracic wall. It is advisable to slip a rubber drainage tube of any desired length over the internal extremity of the tube. Note the rubber membrane that covers the external opening and allows the exit of fluid and air, but prevents the entrance of air.

FIG. 2.

Special bed for drainage, thirty inches wide. Height corresponds to positive pressure apparatus. Mattress projects above end-frames. Large, rubber-tired wheels; brake for two.

FIG. 3.



Illustrates the after-treatment of patients with free drainage after intrathoracic operations as now practised at the German Hospital. The patient's head is inside the positive pressure cabinet; a nurse is with him ready to administer liquids or, in summer time, to fan him with fresh air provided by the apparatus itself through a large tube. The patient's body rests comfortably outside, on the bed without head-piece. An attendant is watching the proper administration of a rectoclysis.

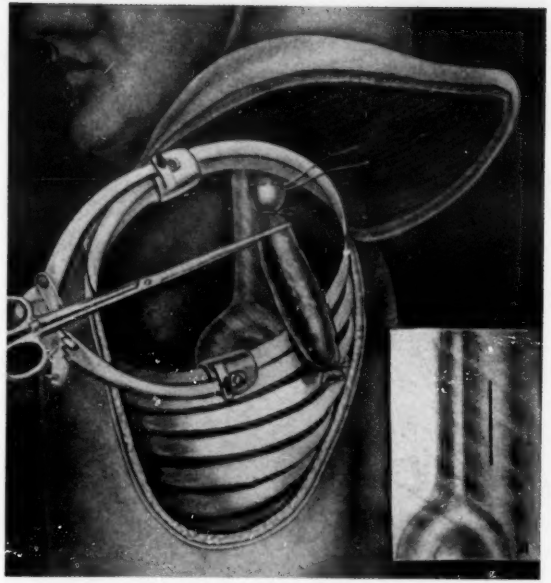
FIG. 4.

The flap raised. With the arm pulled up perpendicularly, the scapula takes a position at right angles with the thorax. When the patient's head is in the differential pressure apparatus, the arm forms a right angle with the thoracic wall. Then by turning the arm inwardly 180° (or the forearm 360°) the scapula moves away from the chest and can be well held out of the way. *A*, incision in sixth; *B*, incision in third intercostal space.

FIG. 5.

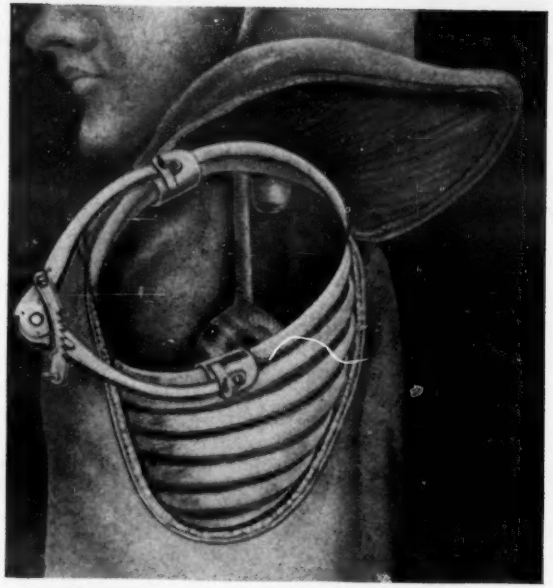
Incision in sixth intercostal space; rib-spreader in place; to the left, lung and diaphragm visible; to the right, the descending aorta still covered by the continuation of the costal pleura; next to it, the œsophagus, divided; lower end inverted; the upper tied with silk. Pneumogastric nerves run on either side, with their anterior osculation. *A*, lower stump of the œsophagus ready for inversion, with the purse-string suture in place. It is best to pull the tube apart with three clamps.

FIG. 6.



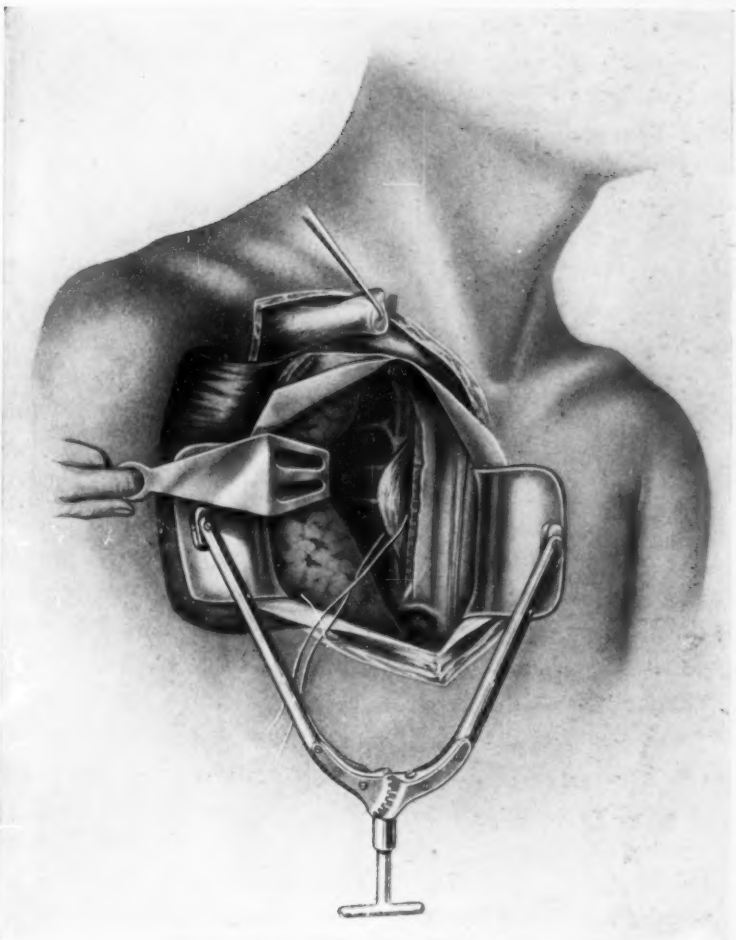
Incision in third interspace; rib-spreader turned around, as scapula is in the way; œsophagus exposed by incision about 1 in. to the outside of the common carotid, which remains covered with pleura, as also does the aortic arch (*A*). The portion of the œsophagus harboring the tumor, pulled from behind the aortic arch, tied and clamped, ready to be divided with Paquelin cautery, completing the resection. The first of the two superior purse-string sutures in place, for inversion of upper stump.

FIG. 7.



Interior of the cavity as it appears after completed double inversion of upper œsophageal stump. Note below the latter the groove in which the œsophagus rested.

FIG. 8.



Sauerbruch's incision to reach the upper portion of the œsophagus from the right side.
(From Sauerbruch-Schumacher, "Technik der Thoraxchirurgie," p. 96.)

the short transport thence to the positive cabinet in the other room seemed inadvisable, if, for instance, both pleural cavities had been opened in loosening the adherent carcinoma of the œsophagus, then the patient's head can be left in the positive cabinet within the negative chamber. In that event the operating table is lowered sufficiently to permit a mattress of the width and length of the operating table to be pushed underneath the patient's body, application of differential pressure continuing meanwhile without interruption. The patient remains therefore under the pressure conditions prevailing during the operation, and the first part of the after-treatment is thus carried on within the chamber.[9]

When the positive pressure apparatus is used, rhythmic changes in the difference of pressure are made for brief periods, every 20 to 30 minutes, in order to relieve the heart, more particularly the right ventricle, and to remove all surplus of carbon dioxide from the lungs. When using negative pressure this will not be necessary, at least not while the pleura is wide open. Whether it will be advisable to change from negative to positive pressure for the after-treatment, as can be done in the universal chamber, further observations will teach.

As to the period of time at the end of which the patient may be safely removed from the apparatus, we first thought that 24 to 48 hours would be the minimum. In trying out the method, however, we were agreeably surprised to find that 12–15 hours was ample. Therefore, after about 12 hours, the differential pressure is turned off and the patient's breathing under ordinary atmospheric pressure observed. If he appears comfortable and pulse and respiration are unaltered, he is transferred in bed to the observation room, where he is left under the care of a nurse. If need be, he can be returned to the apparatus at any moment.

What rôle the rubber dam, covering the wound, plays in allowing the patient to breathe under ordinary atmospheric pressure so soon after the operation, with free drainage of the thoracic cavity, remains to be seen.

[9] This latter plan has not been tried as yet on a patient.

As regards the class of cases in which drainage is particularly indicated, I believe that next to sutured wounds of the lung (Tiegel) and resection or extirpation of the lung, every operation on the œsophagus, in which sutures were used, should be thus treated. In the former, drainage takes care of whatever discharge of fluid and air there may be; in the latter, especially the cases of resection, it minimizes the dangers of acute infection, besides preventing pressure pneumothorax. By adopting drainage of the pleural cavity as a routine measure after operations upon the œsophagus, we shall, I believe, succeed in improving the prognosis of these operations, including resections.

I take this opportunity to plead the continuance of attempts to resect cancer of the œsophagus in whatever part of the thoracic section of the same it may be located, and do this in spite of the fact that not one patient is thus far known to have recovered. Through the constantly recurring disappointments some surgeons have become discouraged and have given up this work; others have for the present excluded from operation the malignant tumors occurring in the upper two-thirds of the œsophagus, the most complicated to cope with, and confine themselves to dealing with those in the lower third and at the cardia.

Personally, I do not approve of this attitude. If progress is to be made in this most difficult chapter of operative surgery, it can certainly not be done by discontinuing our efforts or limiting them to a certain class of cases. We must keep right on exploring this new field of endeavor, until we strike the right path. The knowledge that the operation is technically feasible, as shown by the experiments on dogs, ought to spur us on to make it practically feasible in the human, since we know that the carcinoma of the œsophagus is the most benign of malignant growths in the entire alimentary canal. The difficulty lies in overcoming the immediate shock of the complicated operation, as well as in steering clear of the many lurking dangers of the early after-treatment.

The principal causes of the problem's having remained un-

solved up to the present day are: (1) the usually advanced stage of the disease, when presented for operation; (2) reduced general condition of the patient; (3) the magnitude of the operation; (4) the difficulty of accomplishing air- and water-tight closure of the human œsophagus in view of its extreme thinness and friability.

The first two causes are intimately connected, and we can hardly hope for any change in the near future. We must, therefore, for the present at least, accept them as given facts. As regards causes 3 and 4, however, there is a fair chance of our learning how to mitigate the effects caused by the same.

The ideal operation, resection with immediately following œsophagogastrostomy, can be done in cases of short annular malignant stricture in the lower third of the œsophagus only. These cases are rare. The type of tumor usually met with in this locality is the infiltrating one, necessitating the removal of several inches of the œsophagus. The proximal stump of the tube cannot be stretched; the stomach, on the other hand, cannot be lifted more than three or at most four inches above the diaphragm, owing to the attachment of the duodenum. Hence, there is in these cases no other course open than to close either stump safely after resection and feed the patient through the gastric fistula primarily established. If the patient recovers, he can chew and enjoy his food, but he cannot swallow it. If he desires this, too—and no doubt the majority of patients will—a new œsophagus must be made. This œsophagoplasty has already been accomplished by Payr and Lexer in cases of intractable cicatricial stricture. Of course in the benign strictures the affected part of the œsophagus may be safely left in place, but in the malignant cases it has to be resected. Every one of the 40 to 50 patients thus far treated with resection has died. The salient point, viz., the recovery of the patient from resection, therefore still remains to be accomplished. If we could get but one such case to recover, the faith of both laity and profession in the possibilities of this branch of thoracic surgery would receive a great stimulus.

Closure of the distal stump is simple, as the latter is very accessible. Invagination by means of a purse-string suture and a few interrupted Cushing stitches on top is all that is necessary. There is no pressure on the suture line from the side of the stomach.

In order to safely and properly close the oral stump of the œsophagus after wide resection in its middle or upper portion, it is necessary to pull it from behind the aortic arch. In advanced cases where adhesions exist, and the tumor is situated at or near the aortic arch, this means serious interference with the pneumogastric nerves at a place where the important branches to heart and lungs are given off and communication exists with the complex sympathetic system. Pulling and tearing at this place, however, is not borne by the pneumogastrics; it invariably causes severe, often irreparable shock. Therefore, in order to minimize as much as possible this principal cause of the severe shock, dissection should be done under the guidance of the eyes. One pneumogastric nerve, after proper cocainization, can be divided, but sharply only, *not* bluntly. If both nerves prove inseparably connected with the tumor at or above the aortic arch, the case appears inoperable.[10] To do this work under the guidance of our eyes we must have proper access. This can be gained by getting the scapula out of the way (addition of Schede's incision) (Figs. 4, 5, 6, and 7).[11] The upper part of the œsophagus can also be reached from the opposite (right) side (Sauerbruch,[12] see Fig. 8). The usual incision for œsophageal resection is made on the left side of the thorax. Although I have so far no personal experience in man with Sauerbruch's method of entering the upper part of the thorax I consider the addition of Schede's incision the preferable procedure for wide resection of the œsophagus.[13] It opens the way to gaining entrance

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[10] This important question needs further investigation. It has been shown that below the arch both vagi can, if necessary, be divided, often without any serious consequence.

[11] ANNALS OF SURGERY, July, 1910.

[12] Sauerbruch-Schumacher: Technik der Thoraxchirurgie, p. 92.

through any additional intercostal space, in order to follow up the vagi from below the aortic arch as far as necessary upward. Multiple intercostal incisions do not increase the seriousness of the operation.

But to do all in one sitting is inadvisable. The experience gained from four cases of resection of the œsophagus for malignant tumors of the advanced infiltrating type, with the addition of Schede's incision and displacement of the œsophagus from behind the aortic arch, done *in one sitting*, has taught me that this operation is too much of an undertaking in these reduced patients, even though nitrous oxide plus oxygen with carbon dioxide (Yandell Henderson) be used for an anæsthetic.[14] I have, therefore, resolved henceforth to do the operation in two stages, and am at present engaged in working out experimentally a proper plan.

My idea is, to divide the œsophagus below the tumor and attend to the distal stump in the first stage; thereupon, about one to two weeks later, in the second stage, to do a Schede incision and work on the proximal stump. To attack the upper part of the œsophagus from the right side, according to Sauer-

[13] The illustration (Fig. 4.) shows the typical Schede incision as it is required for the multiple excision of ribs. For the purpose of œsophageal surgery we have to divide the borders of the pectoralis major and latissimus dorsi muscles but for a short distance and raise the skin-muscle flaps with the scapula for hardly more than 75–80 degrees. The arm itself is usually not lifted up much more than to a right angle.

[14] Of the four patients three died from shock, which commenced in each instance at the time of bluntly loosening the œsophagus behind the aortic arch and the attempts of *bluntly* separating from it the adherent nervi vagi. In every one of the three operations the narcotizer reported at this time a sudden change of pulse and respiration. He was in the positive pressure cabinet with the patient's head and had been unable to see what had been done within the thorax. The fourth patient, a man of 66 years, had the cancer in the lower third of the œsophagus and no adhesions at the level of the aortic arch. In this operation, too, the œsophagus was transposed in front of the aortic arch, in order to do proper surgical work when performing double invagination of the upper stump. He had no shock, but died from the effects of a large effusion into the pleural cavity of a serosanguinolent fluid, which compressed the lung. This was at a time when we had not yet adopted free post-operative drainage.

bruch, would usually also mean a two-stage operation. The principal difficulty of a two-stage operation lies in the necessity of closing the proximal stump air- and water-tight, as the patient cannot help swallowing saliva down into the closed tract. From what we have seen in operations upon dogs, a silk purse-string suture properly applied and covered by a freely transplanted fascia graft (König) will do the work. The graft, which, in dogs, is best cut from the upper abdominal (rectus) region, from the fascia lata femoris in man, surrounds the convex end of the stump like a rubber finger cot and heals on tightly in a very short time. The strongest pressure exertable by means of a large hand syringe proved the stump absolutely air- and fluid-proof after 30 to 36 hours. Still, as there may after all be some slight leakage in the hours immediately following operation, I shall in man add free drainage of the thoracic cavity for *both* stages of the operation. It will be an additional safeguard against infection of the pleural cavity and pressure pneumothorax.

My conclusion is that the adoption of drainage as a routine measure after œsophageal resection, in fact after any and every operation upon the œsophagus, will undoubtedly be a step in the right direction.

ACUTE PANCREATITIS WITH VERY EXTENSIVE FAT NECROSIS.*

BY LUCIUS W. HOTCHKISS, M.D.,

OF NEW YORK.

Surgeon to Bellevue Hospital.

THE occurrence of extensive fat necrosis is by no means uncommon in cases of acute pancreatitis. Although it is rarely seen in the hyperacute hemorrhage form of the disease, for the reason perhaps that the patient so rapidly succumbs to the intense primary shock, it is frequently observed in the somewhat milder though still acute types, where the damage to the pancreas is not so extensive and where repair of the lesion, without much impairment of function, is still possible.

Very wide variations, both in the extent and character of the fat necrosis, are found. Small, discrete, widely-scattered, pearly-colored patches, in the omental fat and elsewhere, are characteristic of the milder infections, and the severer cases are marked by massive involvement of the omentum, the subperitoneal and retroperitoneal fat, the pancreas itself and occasionally by the extension of the process to the pleural and pericardial sacs above the diaphragm.

The experimental work of Frugoni and Stradiotti[1] upon animals which had been injected with pancreatic juice obtained from a fistula established for the purpose in a dog clears many points in the histology of fat necrosis and settles some points in the mechanism of its origin and spread.

The conclusions reached by these investigators were, briefly, as follows:

1. That fat necrosis, as has been previously shown, is due to the contact of the pancreatic juice with the fatty tissue.

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* Read before the American Surgical Association, May 29, 1912.

[1] Experimenteller Beitrag. zur Kennt. der Fettgebsnecrose, Berl. klin. Woch., No. 9, 1910, 386-388.

The results of intraperitoneal injection were positive in every case.

2. The focus attacked by the pancreatic juice showed primarily a clear fat necrosis, in which later a reactive inflammation occurs which brings the process to a standstill. Newly formed giant-cells then enter the field, and finally, by the deposition of lime salts, the focus of fat necrosis is converted into a chalk-deposit.

3. A methodical chemical analysis of the fat necrosis showed the presence of a fatty acid, an earthy soap, an alkaline soap, glycerin, peptone, and tryptophane, bound together.

4. It was proven that the uninjured peritoneum exercises a strong protection over the underlying fat, preserving it from the action of the pancreatic juice, and tending to prevent the spread of the necrosis. The factor which leads to the wide dissemination of fat necrosis is most probably to be found in the existence of an accidental or physiological separation of the serous covering.

5. As it was impossible to demonstrate experimentally that fat necrosis is disseminated by way of the blood stream, it was thought most probable by these investigators that its spread was to be explained by regarding the lymphatics as the channels through which extension of the process occurs.

It is interesting to find the results of these experiments corresponding so closely with some of the observed clinical facts. The tendency to spontaneous cure which is evidenced clinically in some mild cases of acute pancreatitis where the diagnosis has been definitely made by an exploratory incision, is thus explained satisfactorily, on the basis of a reactive inflammation set up in the area of the fat necrosis and in the deposit of lime salts as in the spontaneous cure of tuberculosis. If it were possible to detect such cases by means of clinical diagnosis, the waiting policy would of course be clearly indicated. Unfortunately, however, the diagnosis in these acute lesions of the pancreas has not yet reached such a satisfactory stage. In the severer cases, however, with rapid onset and spread of the fat necrosis, it is obvious that the natural processes are in

need of help from the surgeon, who should be able, at least in certain cases, to diminish the tension by efficient operative drainage and so relieve the condition by stopping its further spread, and, in view of the ever present danger of accidental infection from the hollow viscera in the neighborhood, to provide a means for its prevention or its possible relief.

Although it has been shown that fat necrosis is due to the liberation of a fat splitting ferment from the pancreas, either as a result of trauma, hemorrhage, or a surface exudate from the obstruction of its main duct, the reasons for its occurrence in many cases are not always clear. Obstruction of the common pancreatic duct by a stone in the ampulla of Vater forms a satisfying and demonstrable cause in some cases, especially the chronic ones, but in others no such obstruction is found.

The relation of acute alcoholism as a causal factor in cases of acute pancreatitis has been suggested by Moynihan, and in my own case, seems at least probable. By assuming the presence of a gastric or a duodenal ulcer or a catarrhal gastroduodenitis, we have the basis of obstruction and infection which is apparently necessary to cause the final explosion. The symptomatology of acute pancreatitis is unfortunately not sufficiently characteristic to enable one to make the diagnosis with any degree of certainty, so that it comes to be made, if made at all, by means of the exploratory laparotomy, which by reason of the urgency of the conditions is often called for.

Aside from the problems of diagnosis which are of the utmost importance, the still difficult problem of appropriate treatment is constantly presenting itself.

With all this in view, and from the fact that these cases are after all among the surgical rarities, I have ventured to present to this society the clinical history of a carefully observed case of acute pancreatitis occurring in my hospital service, which presented some unusual features.

CASE REPORT.—John M., age twenty-eight, United States, driver, was admitted to Bellevue Hospital October 26, 1910. His previous history was unimportant, save that he states he had never

suffered from any similar attack, and that he was a confessed alcoholic.

For two days before admission, he says he was intoxicated most of the time. On the evening before his seizure, he ate a hearty meal of a pound and a half of beefsteak, some potato salad, some bread and butter, and coffee. Two hours later he took several drinks and went to bed feeling, as he expressed it, in the best of health. He slept until 2 A.M., when he was awakened by a sharp stabbing pain in the pit of the stomach, for the relief of which he got up, went out to a bar-room in the neighborhood, and drank two glasses of whiskey, which he almost immediately vomited. He had also a very loose movement of the bowels at this time but pain was not relieved, so he went back to bed where he continued to suffer from severe abdominal pains and vomiting until brought to the hospital in the late afternoon. His pain by this time had become more general over the whole abdomen, he had vomited repeatedly, and complained of feeling chilly and feverish and of sweating profusely at times. He was carefully examined on his admission to the medical ward, and the usual examinations of blood and urine were made. His temperature at the time of admission to the hospital was 101.2°, pulse 100, and respirations 28. He looked alcoholic, his face was flushed and he appeared very sick. His abdomen was somewhat tympanitic and tender over the region of the appendix, and especially so above the umbilicus, where the abdominal wall was rounded and very tense.

He had a leucocytosis of 26,800, with a polynuclear percentage of 89 per cent. His urine was of high specific gravity, 1034, with a trace of albumin and bile, a few hyaline and a very few granular casts and white blood-cells. His heart and lungs were negative, and his spleen was not enlarged.

On the day following, there was slight increasing resistance in the upper right abdominal quadrant and dulness in the right flank. There was also some muscular rigidity and tenderness noted over the upper segment of the right rectus. The temperature had risen to 102.8° and the pulse to 120. The case was seen at this time by a surgical colleague, who declined to operate as the condition was not clear. On the next day the temperature dropped to 100° and did not reach 102° again until three days later, the day before operation. Coarse friction developed in the

left lower axilla and the patient complained of pain on deep inspiration, so that developing pneumonia was suspected. There was also some flatness on both sides just below the angle of the scapulæ, and the patient appeared very sick. The blood count remained high as before and showed a polynuclear percentage ranging from 87 to 90. On October 31, five days after admission, a well-defined rounded mass was made out situated chiefly in the mid-epigastric region and reaching down to within a finger's breadth of the umbilicus. The upper limits shaded off into the muscular resistance. The mass was dull on percussion, rather tender, firm, and elastic to the touch, and above it was a well-marked area of tympany. On November 1, the next day, the case was first seen and examined by the writer, and although the definite differential diagnosis of acute pancreatitis was not possible, the condition was suspected and an immediate operation advised and done as soon as preparation could be made.

Operation (Nov. 1, 1910, Dr. Hotchkiss).—Ether anæsthesia. Laparotomy above the umbilicus through the inner fibres of the right rectus muscle was done.

Upon opening the abdomen an enormously thickened omentum which was lightly adherent to the anterior abdominal wall was disclosed. This was very evidently the seat of an extensive fat necrosis which at once established the diagnosis. As the patient's condition was very bad, the gall-bladder was not searched for through the adhesions and its condition was not determined. A finger was thrust through the lesser omentum, which was very thick, and the seat of extensive fat necrosis, and the lesser peritoneal cavity was opened, giving vent to a considerable quantity of bloody fluid under pressure together with numerous lumps of tissue, apparently necrotic fat and fibrin. The pancreas was easily palpated but its exact condition could not be made out any further than to discover that it felt harder in some places than in others. A large cigarette together with a wrapped split drainage tube was carried to the bottom of the lesser sac, the abdominal wound closed to the drains, and the patient returned to bed.

His condition improved somewhat after the operation, the pulse becoming a little less frequent and the temperature tending generally below 101°. The blood count however continued high, appetite failed, and the patient grew steadily weaker and much emaciated. It soon became evident that the anterior drainage

alone was inefficient, and a second operation was advised and done on November 19. At this operation, the anterior sinus was excised and the wound reopened. The patient was turned over on his face, and a broad incision parallel with the twelfth left rib was made, opening into the lesser sac from behind. From the large pieces of necrotic tissue which were washed away it was evident that we had to deal with a very extensive fat necrosis of the retroperitoneal tissues. A large fragment of tissue which was washed from the wound was submitted to the pathologist and found to be a portion of necrotic pancreas. This piece and others resembling it were dry, crumbly, and evidently in a condition of fat necrosis. Through-and-through tube drainage was arranged and the patient who was in considerable shock was returned to bed, where he quickly rallied. The temperature fell but rapidly rose to 104° on the second day and then gradually receded. The drainage was very profuse for the first few days, necessitating frequent change of dressings, and irrigation continued to bring away large amounts of necrosed fatty tissue and purulent fluid.

The discharge soon diminished and the drainage openings contracted rapidly and soon were nearly closed. The patient remained very white, feeble, and emaciated, and all our resources were taxed to provide him with food which could be assimilated. For a time he barely held his own and then his appetite began to return and he began to gain in strength and flesh and color. On December 16, a faintly positive Cammidge reaction was obtained, and the posterior wound had nearly closed. The rubber drainage tubes were removed as early as possible for fear of pressure necrosis. The temperature fell to nearly normal, the pulse had much improved in quality, and the anæmia was less apparent. On December 21, however, just as his improvement had become well established and he was eating well and enjoying his food, he had a sudden profuse discharge of fluid from the anterior sinus, which was found to contain most of his recent meal. The diagnosis of stomach perforation was confirmed by allowing the patient to drink water tinged with methylene blue, which almost immediately flowed out of the wound sinus. The patient's strength began to fail very rapidly and it became evident if he were to be rescued from starvation an attempt would have to be made to find and close the opening in the stomach.

Accordingly six days later, on December 27, the patient was

taken to the operating room for the third time and his abdomen again opened under ether anæsthesia. As the attempt was extremely hazardous in his very weak condition, he was first infused with saline solution. His abdomen was painted with tincture of iodine and the track of the original anterior incision together with the sinus was excised. On exploring the anterior wall of the stomach no perforation could be seen and as the organ was adherent lightly along the greater curvature, and as much handling of the viscera was out of the question in the patient's feeble condition, an incision was rapidly made through the anterior wall of the stomach and a small perforation quickly discovered upon the posterior wall, just above the greater curvature. The adhesions along the greater curvature were easily broken up and with one finger in the cavity of the stomach the perforation was easily pushed forward into the wound, where it was quickly surrounded with a purse-string suture, dropped back, and the incision in the stomach closed, with the loss of but little time. The abdominal wound was closed to a small cigarette drain and the patient put back to bed in a condition of severe shock, from which, however, he quickly rallied. A period of careful rectal feeding followed and after a week, careful stomach feeding was resumed. The patient gained very rapidly in flesh and strength and went on to an uncomplicated and apparently perfect recovery. He reported several months after his discharge from the hospital, showing an enormous gain in weight and being apparently in perfect health.

The question which naturally arises with respect to the late perforation of the stomach, as to whether it was due to pressure necrosis or to pancreatic digestion of a damaged portion of the stomach wall, or to the pre-existence of a gastric ulcer, can of course not be answered.

ACUTE DIVERTICULITIS OF THE SIGMOID FLEXURE OF THE COLON.*

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At the 1907 meeting of the American Surgical Association, W. J. Mayo and George E. Brewer presented the subject of diverticulitis of the sigmoid, the former discussing the affection from the stand-point of chronic thickening simulating carcinoma, the latter from that of left-sided suppuration simulating appendicitis. So important were these communications that Fitz, of Boston, taking part in the discussion by invitation, said that, "They made a fairly complete picture of what must be recognized as a new disease of the lower abdomen: diverticulitis of the left quadrant analogous to appendicitis of the right quadrant." So far as I am able to learn these were the first clear pictures which had been drawn. Pathologists had recognized inflammatory affections of the sigmoid in the course of their post-mortem examinations, but clinicians were lacking in appreciation of the importance of the conditions.

A number of communications have been made on this subject since the appearance of these important papers by Mayo and Brewer. Notable among these are those of:

Telling (*The Lancet,* vol. i, 1908; *The Proctologist,* March, 1911), Anschütz (*Centr. f. Chir.,* 1909, p. 1176), Moure et Desbouis (*La Presse Méd.,* No. 104, 1909), Hartwell and Cecil (*Am. J. Med. Sci.,* vol. cxl, 1910), Dunn and Woolley (*Am. J. Med. Sci.,* vol. cxlii, 1911), Bruce (ANNALS OF SURGERY, May, 1911), Erdmann (*Yale Med. Monthly,* Feb., 1912), Cameron and Rippmann (*Guy's Hospital Reports,* vol. lxiv, 1910), Zengerle (*Centr. f. Chir.,* 1912, p. 275), Barbat (*Surg., Gynæcol., and Obstet.,* March, 1910), Franke

* Read before the American Surgical Association, May 30, 1912.

(*Deutsche med. Woch.*, No. 3, 1909), Neupert (*Arch. f. klin. Chir.*, vol. lxxxvii, 1908), Wilson (ANNALS OF SURGERY, Feb. 1911), Chiari (*Centr. f. Allgem. Path.*, vol. xxii, 1911), Eibegger (*Prager med. Woch.*, No. 43, 1910), Verdenal (*Thèse de Lyon*, 1907). Some of these, especially the papers written by Telling and by Hartwell and Cecil, are analytical and exhaustive,[1] others present in detail the histories of carefully observed cases. The pathological condition is a definite one[2] and must be borne in mind by clinicians when considering affections of the left lower quadrant of the abdomen. These diverticula are of the variety known as false, they are acquired, they are more often found in males than in females, and they are particularly observed in obese individuals at or near mid-life who have suffered from flatulency and constipation. My belief that acute diverticulitis occurring in these obese people is a grave condition leads me to report the following illustrative case:

CASE I.—Mr. B., age forty-nine years, unmarried. Height 5 feet 9½ inches, weight 240 pounds. Chronic bronchitis for many years, "ailing" off and on for many years. History of acute appendicitis 17 years ago. Right oblique inguinal hernia for the past six years, this controlled by a truss. No definite kidney history. The bowels have at times been loose, at times markedly constipated. Patient very obese, full reddish face. He has been a very heavy eater and has taken practically no exercise.[3]

Present Illness.—November 15, 1911: "Bilious." Bowels emptied thoroughly by compound cathartic pills, these repeated two nights. Free, large movements.

November 18: Felt rather badly. Nine or 10 bowel movements.

November 19: Seen by Dr. C. E. Edson. The urine was

[1] An excellent bibliography accompanies the paper of Barbat.

[2] While this communication considers only diverticulitis of the sigmoid, the most frequent seat of diverticula, it is to be borne in mind that intestinal pouches, both false and true, are met with in other portions of the large intestine and throughout the length of the small intestine.

[3] I have known him intimately for 17 years and he has always impressed me as being a very poor surgical risk.—C. A. P.

normal. Patient complained of soreness at and above the left groin and of discomfort over the lower part of the descending colon. He was tender on pressure at the sigmoid region on the left side. The pulse and temperature were normal.

November 20: The patient said that he had pain in the lower abdomen throughout the night. Since then he had been on the verge of chilliness. He had had no bowel movements since 5 o'clock of the previous afternoon. At 4 P.M. the temperature was 101.5°, the pulse 90. Pain and tenderness over the lower left quadrant of the abdomen. At 6 P.M. (November 20) he was seen by me in consultation with Dr. Edson. *Notes:* The temperature was 101°, the pulse 90. There had been no vomiting; the patient was in bed; his facial expression was fairly good, he complained of moderate pain in the lower left quadrant of the abdomen. He has had no definite urgency of urination, he has had no rectal tenesmus. There has been no blood in the stools, there has been no rectal discharge. *Physical examination:* The abdomen showed no distention on inspection. It was very full, through fat, but did not impress me as being distended. There was an exquisitely tender area the size of the palm of the hand midway between the navel and the left anterior superior spine. This area was very tender on even light pressure. The abdomen at this point was very rigid; the remainder of the abdomen was free from rigidity. Deep pressure in the region of the appendix elicited a little tenderness but this was not at all marked. Nothing was found in the region of the stomach or liver. Digital rectal examination showed a somewhat enlarged prostate, it elicited no tenderness, and met with no resistance. The right testis seemed normal, the left testis was not to be felt. The patient was immediately sent to the hospital and a blood count ordered; this showed a leucocytosis of 26,000 and a differential of 77 per cent.

Note.—This man impressed me as having a definite and urgent surgical affection of his left lower quadrant. He was exquisitely tender and quite rigid, he had a moderate fever, he had a high leucocytosis. Despite the fact that I believed him to be a very unfavorable surgical risk I felt that his abdomen should be explored. He may have had an acute diverticulitis,[4] a badly

[4] I do not feel that one should say that a pre-operative diagnosis of acute sigmoid diverticulitis was made in this case; the condition was simply thought probable.

placed appendix, a thrombosis with intestinal gangrene. The condition may have been one of many things, but I believed it to be surgical.

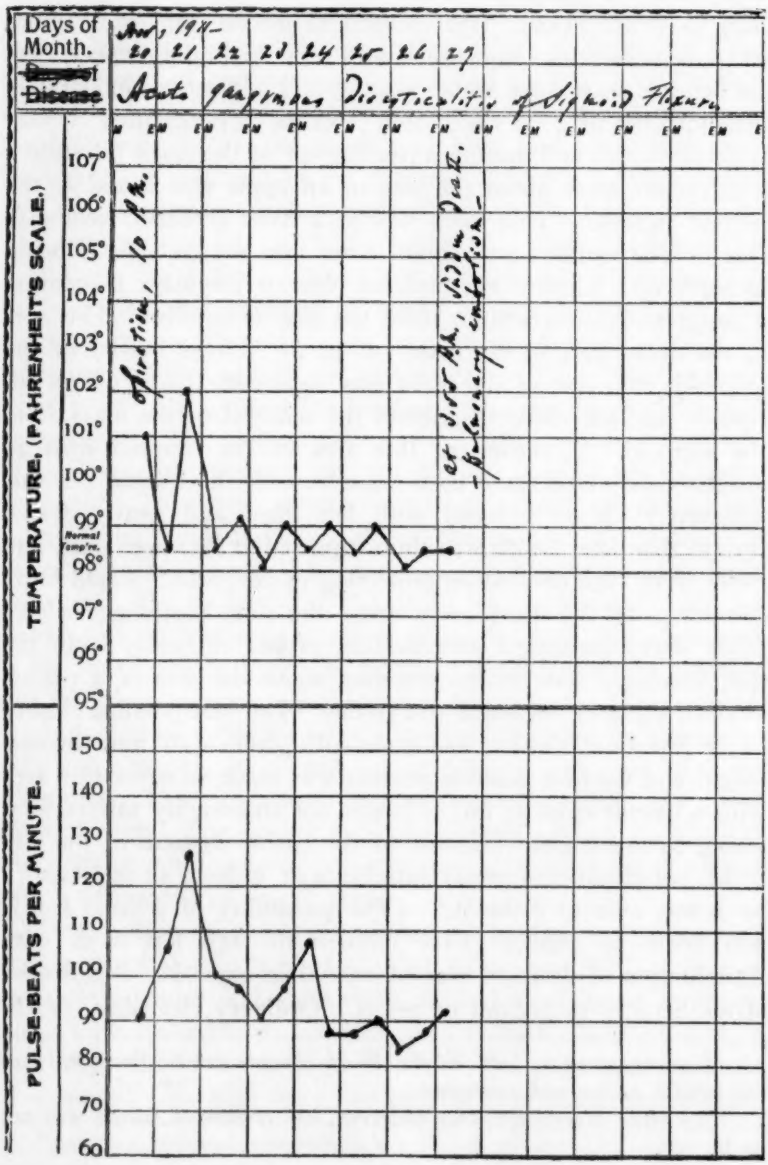
Operation[5] (at St. Luke's Hospital, 10 P.M., November 20). —Ordinary iodine preparation. Patient in moderate Trendelenburg position. Long, free incision in median line from pubes to above umbilicus. Abdominal wall very thick, the preperitoneal fat being at least three inches in thickness. Intestines moderately distended but of good color. No evidence of peritonitis. Under wide retraction and thorough packing off of the small intestine a gangrenous mass about the size of an apple was found at the middle sigmoid. This mass was of a dark greenish, yellowish color. The sigmoid was bound down and not capable of being brought up. Careful examination showed the mass to contain a gangrenous diverticulum about the size of an olive. This was at the upper part of the mass and at the convex border of the sigmoid; the rest of the mass was apparently made up of fat. Speedy decision made to attempt the removal of the mass from the sigmoid. (Excision of this area of the sigmoid with an anastomosis would have been fraught with the utmost possible difficulty.) Mass grasped with left hand and gently drawn up; at this time the diverticulum ruptured at its upper part, and fæces were extravasated on protecting gauze packs. Rapid knife dissection of the mass away from the gut, beginning below; fairly sharp bleeding; diverticulum proper cut away from the gut, leaving a hole in the intestine about the size of a penny. Wall of sigmoid thickened and friable. The best possible closure of the intestinal opening was made with plain catgut and chromic catgut and the best possible attempt was made to cover this area with adjacent epiploic fat. Closure not thoroughly satisfactory, owing to the friable condition of the entire segment of the sigmoid, but considered pretty satisfactory; indeed, as satisfactory as I was able to make it.[6] (The possibility of a fecal fistula was borne in mind.) Free incision through left flank with introduction of drain to seat of wound in sigmoid. Small tube above bladder to bottom of pelvis. Ordinary cleansing. (Ab-

[5] I am indebted to Drs. Edson, W. S. Bagot, and S. Fosdick Jones for helpful advice and assistance.

[6] No other diverticula were observed, but prolonged search was not made.

dominal left testis discovered.) Suture of abdominal wound. Time of operation something over one hour; condition of patient good at close, pulse about 100.

FIG. 1.



During the three days following operation the course was rather stormy. The urine showed a heavy ring of albumin and granular casts. Both lungs showed fine and coarse râles. There was no vomiting, and while the intestinal distention was marked, yet it was possible to relieve gas in a fair degree. Five days after operation the condition seemed very satisfactory. The temperature was normal, the pulse was 94 to the minute and of excellent quality. The patient was passing gas freely, the facial expression was good, the subjective symptoms were good. On this day a fair-sized liquid bowel movement contained a moderate amount of bright and dark blood; this appearance of blood did not recur. On November 27, seven days after operation, the temperature was normal, the pulse averaged 90 to the minute, the patient was comfortable; he was sleeping well and passing a large amount of gas. His recovery seemed assured (see clinical chart). I saw him at 2 P.M., at which time his condition was in all ways good; he was entirely comfortable. At 2.45 P.M., he suddenly complained of excruciating thoracic pain and became ashen in color, gasping for breath. The pulse, as taken by the nurse, was very weak and irregular, almost imperceptible. I reached him a few moments later, at which time he presented the typical picture of pulmonary embolism. He was hardly conscious, he failed steadily, and died at 3.55 P.M., one hour and ten minutes after his first thoracic symptom.

An examination of the abdomen was made four hours after death. There was no peritonitis, the sutured area at the sigmoid was intact. There was a moderate plastic exudate at the site of suture. The chest was not examined, as the symptoms of pulmonary embolism were classical.

We have in this case an acute gangrenous diverticulitis of the sigmoid, in which operation was done at a comparatively early hour, certainly before rupture or peritonitis had occurred. The gangrenous area was excised and the opening in the sigmoid sutured. The patient was apparently making a good recovery when he suddenly succumbed to pulmonary embolus on the seventh day. When the abdomen was examined after death it was found to be clean.

It is not easy to positively segregate the reported instances

of the acute form of diverticulitis; some overlapping must necessarily occur. I am able to collect from literature hardly more than a dozen cases submitted to operation (Cameron and Rippmann, Brewer, Mertens, Wernecke, Erdmann, Barbat, Bruce, Hartwell and Cecil); of these, almost all which were attended by perforative peritonitis died, while of those in which an abscess was opened and drained almost all recovered. I am unable to find the analogue of the case reported in detail in this communication, although it is more than probable that such exists. Certainly the danger of perforation in acute diverticulitis is grave [7] and this renders early diagnosis [8] and prompt operative interference of great importance. While the condition is analogous to appendicitis, the operative management is less simple than is that of the acute inflammations of the appendix, and it is with this thought in mind that I venture to bring the subject through with but a single illustrative case, before the Association.

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[7] A large proportion of the literature of the subject is based on autopsy findings.

[8] The symptoms are practically those of an acute appendicitis of the left side. Telling (*loc. cit.*) gives an excellent résumé of the occurrence, pathology, and forms of diverticulitis.

HEMORRHAGE INTO THE PERITONEAL CAVITY CAUSED BY ACCIDENTAL RUPTURE OF THE OVARY.*

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As the result of a severe strain a blood cyst of the ovary may rupture and cause serious or even fatal hemorrhage into the peritoneal cavity. After careful consideration of the two cases recorded in this paper, together with a study of the literature of intraperitoneal hemorrhage of ovarian origin, one must inevitably conclude that such an accident is not only possible but that in all probability it is of much more common occurrence than we imagine.

The most common cause of intraperitoneal hemorrhage in women is dependent upon an extra-uterine gestation. It is no doubt true, as has been suggested by some writers, that the possibility of other etiological factors being active in its production has been overlooked, because in an enormously large percentage of cases a ruptured ectopic pregnancy is found to be the source of the bleeding. An analogy exists in the confident fashion in which surgeons diagnose appendicitis whenever localized peritonitis manifests itself in the right iliac fossa. In the vast majority of instances such conclusions are correct, but with wide experience we are led to believe that, as a fact, an absolutely assured diagnosis of acute appendicitis is rarely possible.

In this paper we are not concerned with a ruptured ectopic pregnancy as a cause of intraperitoneal hemorrhage, excepting perhaps to be reminded of the indirect effect of an extra-uterine gestation in causing a congestion of the ovary, which may in

* Read before the American Surgical Association, May 29, 1912.

turn lead to the production of hemorrhagic cysts, and these may rupture. This fact should be borne in mind by the operating surgeon; both ovaries should be carefully examined during the operation, else a fatal error might be made in failing to check hemorrhage from an ovary which is in no way connected with the gestation sac.

The cases which I now record were not connected with pregnancy. In both instances what appeared to be a normal Graafian follicle had ruptured as the result of an accidental strain. In one instance the patient lifted a heavy weight and the rupture immediately occurred. In the other case the patient had a violent attack of vomiting in the early stage of an acute appendicitis and this brought about a similar result. In both instances serious hemorrhage occurred into the peritoneal cavity and almost proved fatal in one of my patients. The histories are as follows:

CASE I.—*Profuse hemorrhage from the accidental rupture of a Graafian follicle into the peritoneal cavity. The rupture was caused by a strain while lifting a heavy weight. Operation. Recovery.*

Mrs. R., age thirty-five, was the mother of twin boys three and a half years old. There had been no other pregnancy. The menstrual history was normal. Two days before her period was due, at eight o'clock in the morning, while attempting to lift a heavy chest she experienced sudden severe pain in the lower part of the abdomen. She became nauseated and had frquent attacks of vomiting during the day with continuance of the pain. Twelve hours after the onset of her trouble she was seen in consultation. She was very anæmic, her face bore a pinched and anxious expression. Her temperature was 97.6° F. and her pulse 130. There was marked abdominal distention with a wall uniformly rigid. Palpation at once induced vomiting. There was general tenderness, but this was most marked in the left iliac and hypogastric regions. *Per vaginam* a mass was felt which crowded the uterus down and fixed it firmly. Pressure on this mass induced great pain. On opening the abdomen a very large quantity of blood was found free in the peritoneal cavity. This was fluid in the upper part of the abdomen, but in the pelvis and about the

uterus it was clotted. The clot showed some tendency to adhesiveness, sufficient to account for the fixation of the uterus. The left ovary was somewhat larger than normal, and upon its upper free border existed a ruptured hemorrhagic cyst the size of a hazel-nut. Arterial blood was spurting in a pulsatile fashion from a definite point. The ovary and tube were removed together with much of the clots and fluid blood. The right ovary and tube were normal.

The patient made an excellent recovery, but for the first ten days an evening temperature of about 100° F. was noted. This doubtless was due to the peritonitis which is more or less an invariable accompaniment of hemorrhage in this locality.

The pathologist reported that the specimen in the gross showed a corpus luteum (2½ x 2 cm.) with evidence of recent rupture. There was no pregnancy.

CASE II.—*Hemorrhage into the peritoneal cavity due to a ruptured Graafian follicle complicating an attack of acute appendicitis. The rupture was caused by strain induced by a violent attack of vomiting.*

The patient was forty years of age, married, and an exceptionally active woman. A few years previously she had a small cystic adenoma removed from the breast. She has had occasional attacks of indigestion characterized by flatulence and abdominal distress, and there has been a tendency to constipation. The menstrual history was normal, and her present attack developed two days before a period was due. She had never been pregnant.

At two o'clock in the morning she wakened with acute pain in the abdomen. She had been at the theatre the night before, and on her return home had felt some distress and unrest in the abdomen but no definite symptoms of local trouble. In the morning her physician found her with a normal pulse and temperature and complaining of some tenderness over the lower part of the abdomen. An enema at 10 A.M. was followed by a violent attack of vomiting, which left her very sore and with definite tenderness in the right iliac region. At 6 P.M., in consultation, one found acute pain on pressure over the appendix region with slight but marked local rigidity. The pulse was 80 and the temperature normal. She had no nausea. A diagnosis of appendicitis was made.

Operation was performed at 10 P.M., 20 hours after the first appearance of symptoms and 12 hours after the violent attack of

vomiting. The moment the peritoneum was opened in the appendix region fluid blood welled up in the wound in large quantity. Toward the pelvis some dark clots were found. An incision was now made in the middle line and a large quantity of dark blood-clot was found filling the pelvis. The left ovary and tube were normal. The right ovary was considerably enlarged, and a cyst about the size of a hazel-nut was ruptured on its anterior aspect. Adherent to this was a blood-clot. It was quite obvious that the ruptured Graafian follicle was the source of the hemorrhage. The ovary and tube were removed. Attention was now turned to the appendix, and through the primary incision in the right iliac region one removed that organ, which was acutely inflamed and adherent. The pathologist made the following report on the material removed:

"The specimen received consists of appendix, ovary, and distal portion of the tube. The ovary is enlarged and ruptured on its anterior aspect. Adherent to the ruptured portion is a fairly large amount of clotted blood. Microscopical examination: The appendix shows acute inflammation in the mucosa and also an acute peri-appendicitis, as evidenced by the presence of fibrin and pus on its peritoneal surface. Sections through the ovary show the remains of a Graafian follicle which has ruptured into the peritoneal cavity and from which hemorrhage has taken place. There is no evidence of pregnancy or malignancy."

The sequence of events in this case is quite obvious. The patient had an attack of acute appendicitis two days before her monthly period was due, and a violent attack of vomiting had brought about rupture of a Graafian follicle. The hemorrhage into the peritoneal cavity had been slow and had shown no symptoms, but was only discovered when the abdomen was opened for the removal of the appendix 12 hours afterward. Had the patient been left until morning she not only would have run considerable risk from an attack of acute suppurative appendicitis, but she might have lost her life from hemorrhage.

These two cases have some points in common. Thus an accidental strain caused rupture of an ovarian blood cyst and induced the hemorrhage. In both the Graafian follicle was ruptured two days before a menstrual period was due. In each

instance one observed that the extravasated blood was clotted in the pelvis and had remained fluid in the upper part of the peritoneal cavity. This last observation may bear some relationship to the circumstance that the pelvic and lower abdominal zone of peritoneum shows greater resistance to septic trouble than the upper regions of the peritoneum. The local conditions which lead to a higher degree of resistance may likewise favor clotting and induce the tendency to adhesiveness which on the one hand in the presence of effused blood leads to the production of the so-called pelvic hæmatocele and on the other hand by the production of adhesions may produce a localized abscess well walled off from the general cavity. Pus like blood is more likely to become diffused and to remain free in the upper zones of the abdomen and more likely to be limited by adhesions in the pelvis and in the lower abdominal zones.

Jayle, in his paper on retro-uterine hæmatocele caused by the rupture of a blood cyst of the ovary, is very emphatic in his opposition to the usual teaching regarding the etiology of pelvic hæmatocele, for example, he calls attention to the fact that Pozzi in his treatise on gynæcology makes a statement, printed in italics, intended as an aphorism for the guidance of practitioners which reads as follows: "*L'hématocèle enkystée est un accident de la grossesse ectopique.*" In English text-books likewise, little attention is paid to this very important subject. The frequency with which an ectopic pregnancy is found to be the source of the bleeding has so impressed the various writers of such works that they treat this aspect of the subject in an exhaustive fashion but give scant attention to the possibility of rupture of an ovary causing hemorrhage in the absence of pregnancy. The writer in Kelly and Noble's treatise on gynæcology and abdominal surgery makes no mention of free hemorrhage into the peritoneal cavity. He says that "a pelvic hæmatocele is formed of an effusion of blood into the peritoneal cavity which subsequently becomes incapsuled. In the great majority of cases the condition results from tubal pregnancy . . . . other causes of pelvic hæmatocele rarely

exist." Webster dismisses the subject by saying that occasionally an effusion of blood may be brought about during menstruation usually from sudden strain, and mentions the fact that this may occur with the rupture of a Graafian follicle. Hermann enumerates the causes of great hemorrhage into the peritoneal cavity as (1) rupture of a pregnant Fallopian tube; (2) rupture of a varicose vein; (3) rupture of an ovary; (4) rupture of the gravid uterus. He makes the following interesting statement: "There is a physiological bleeding, not enough to give trouble, into the Graafian follicle with ovulation. It has been supposed that this physiological congestion may, by accidental causes acting shortly before the time of ovulation, be so increased that the bursting of a Graafian follicle will cause bleeding enough to form a hæmatocele. This is theory; there is no evidence that a healthy ovary ever bleeds enough to form a hæmatocele." Hermann, however, states that when a blood cyst forms pathologically in an ovary it may assume large proportions and the hemorrhage from this may be sufficient to kill the patient.

The possibility of serious hemorrhage occurring from rupture of a Graafian follicle was recognized as far back as 1851 by Nélaton, by Rokitansky in 1855, and by Puech in 1858. The last author applied the term "apoplexy of the ovary" to the rupture of a Graafian follicle, which he says may cause fatal hemorrhage into the peritoneal cavity. It has been suggested that these older writers did not recognize ectopic pregnancy, which it is claimed must have been a cause which was overlooked in many of their cases. It is true that no very special attention was given to extra-uterine pregnancy until 1883 when Lawson Tait first operated for its relief, and there can be no doubt that many cases described as hemorrhage of ovarian or tubal origin were really those of ectopic gestation. But some of the more minute details are given in certain cases by these older authors, which seem to show beyond doubt that they had cases of serious hemorrhage from ruptured ovaries in the absence of pregnancy.

The writer wishes to urge that more attention should be

given to accidental hemorrhage from the ovary such as is illustrated by the two cases herein recorded. The condition is probably not extremely rare; thus one finds numerous instances in searching the literature. For example, Wilson reports eight cases of hæmatoma of the ovary occurring in the clinic at St. Bartholomew's Hospital; Holmes records two cases of pelvic hæmatoma of ovarian origin; Hind reports a case of a very large intraperitoneal extravasation of blood from rupture of a Graafian follicle of the left ovary. The patient recovered after operation. Penny describes a somewhat similar case of hemorrhage from the right ovary; Lockyer records three cases of extensive intraperitoneal hemorrhage of ovarian origin; Fordyce reports two fatal cases of peritonitis following menstrual suppression, in one of which the bleeding, which had come from a cyst in the right ovary, had led to the formation of an encysted hæmatocele which suppurated. Jayle reports 17 cases, three under his own care and 14 from the literature. In two of these a blood cyst was ruptured during examination under an anæsthetic. Doran reports a case of hemorrhage into an ovarian cyst due to torsion of its pedicle.

The tendency to development of blood cysts of the ovaries in a bilateral fashion is quite striking, so much so that our judgment must be markedly influenced by the circumstance. Jayle called attention to this fact, and in one of his cases, where he had operated for hemorrhage from a ruptured cyst of the ovary on one side, the symptoms recurred some months after and he had to remove the other ovary for a similar condition. He advocates double oöphorectomy when called upon to operate, particularly in women no longer young. This suggestion of bilateral development implies a pathological condition of the implicated ovaries. Jayle considers this to consist of hypertrophy and exaggerated development of the ovarian capillaries. The rupture of such bilateral hemorrhagic cysts is also described by Hedley, Lockyer, and by Giles.

A number of cases are on record where an error of diagnosis has been made because the condition present simulated acute appendicitis. Two of the cases reported by Lockyer were

examples of this and were operated on by Mr. Stanley Boyd; in each a hæmatocele was present but the appendix was normal. Wilson also mentions this error in diagnosis and in addition an instance where the diagnosis of perforated gastric or duodenal ulcer was made. The local signs of trouble in the right iliac fossa, with vomiting and elevation of pulse and temperature, may so simulate acute appendicitis as to make a positive opinion impossible. The diagnosis too from a ruptured ectopic gestation cannot always be made until the abdomen is opened or the implicated organs carefully examined in the laboratory. Again these two conditions may co-exist.

As far as I am aware the second case recorded in this paper is the only one in the literature where an acute septic appendicitis was complicated by serious intraperitoneal hemorrhage from the accidental rupture of a Graafian follicle. It suggests to the writer that possibly some of the instances of fatal peritonitis reported, in which the rupture of a blood cyst of the ovary was looked upon as the primary cause, really had their origin in an acute appendicitis or some such analogous septic condition, and that the rupture of the ovary was an accidental accompaniment due to strain, with something like the sequence of events described in my case. This view is further strengthened by the fact that in some instances the amount of blood effused was extremely small, and the authors have expressed surprise that such a small quantity of blood should have produced such grave results.

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TUBERCULOSIS OF THE BLADDER, URETER, AND KIDNEY.*

REPORT OF CASES

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I HAVE always been under the impression that tuberculosis of the kidney, ureter, and bladder was a rare occurrence, and that the number of such infections was small. When very recently I found that I had six such cases under observation at the same time, I came to the conclusion that it was more than a coincidence. As I look back at my early surgical experience, I realize that many of these cases have been missed. They come to the physician, not for disease of the kidneys or for pain in the back, bloating, or other such symptoms usually ascribed to the kidneys, but on account of persistent bladder distress, frequent, and painful urination. Almost without exception this is the first, as it is the most important, danger signal in this class of cases. Occasionally these people will have passed small quantities of blood in the urine; usually the blood will be small in amount, but there may be times when there will be enough blood passed, to make one think of bladder tumor or kidney stone. As Newman says, " Hæmaturia is almost as certain a sign of tubercular kidney, as hæmoptosis is of pulmonary phthisis." The plan which we have all been accustomed to follow in these cases has been to make a diagnosis of cystitis, give some prescription which would correct the over-acidity or alkalinity of the urine, and usually to give urotropine in an empirical way; later when the patient did not improve, we have used some form of bladder irrigation, changing the solution or its strength, vainly trying to find something which would help these people. Washing out the excess of pus from the

* Read by title before the American Surgical Association, May, 1912.

bladder combined with the "faith cure" would make these people believe for a time that they were better. But Braasch is undoubtedly correct when he says that "no one is justified to-day in treating locally a case of bladder irritability until all means have been exhausted to exclude the existence of renal tuberculosis." When tuberculosis of the bladder is proven we may then safely conclude that over 90 per cent. of such cases are secondary to some form of inflammation in one kidney if in the early stages of the disease, or in both kidneys if seen late in the progress of renal tuberculosis. Primary bladder tuberculosis is extremely rare, according to Kummell of Hamburg, who is one of the best authorities on the subject. Infections of the bladder from a primary tuberculosis of the testicle, where the infection has ascended along the vas deferens to the seminal vesicle and then to the prostate, is extremely rare.

Kummell also states that when in such a case the bladder is involved, it usually means that there is a separate focus in one kidney, quite separate from the genito-urinary tuberculosis.

I have been very much interested of late in looking up the subject of renal tuberculosis from the medical side, for the reason that I have recently heard that the best internal medical men of the country did not believe that tubercular nephritis was often surgical, but should usually be treated with tuberculin and the fresh-air cure, consequently I turned to the standard authorities on internal medicine.

I find that Osler in his last edition turns the discussion of this subject over to J. Tilden Brown, formerly the genito-urinary surgeon at the Presbyterian Hospital, New York. The same is true of Allbut and Rolleston's "System of Medicine" of 1910. Here Sir Henry Morris the English surgeon is the one who wrote upon tubercular nephritis; consequently both these authorities agree with the modern surgical teaching. But the most surprising to me was the conclusions of Wagener of Leipsic, given by my colleague, Dr. Chas. L. Greene. He says that the spontaneous healing of a badly infected tubercular kidney was very rare and that tuberculin has only exceptionally brought about healing. He not only advises removal of a

badly diseased kidney, but also says that he has found that other tubercular foci have been healed after nephrectomy, the other kidney of course being healthy. As he says, tubercular apices of lungs, tuberculosis of bones and joints, tuberculosis of testicle and seminal vesicles have healed, and such complications are in no way contraindication to the operation.

So I find that my informant was not correct, and that the best internal medical men take the same position that the surgeons do. Now when are these cases medical and not surgical? The very early cases of tubercular nephritis in children, when properly taken care of, do recover, as for instance in Case I reported in this paper.

In cases where both kidneys are badly infected or when only one kidney exists, the other having been destroyed by the disease, also after nephrectomy, these patients should always be instructed to keep under medical observation, and especially when the cystitis does not clear up. We all know that Kroeneline is correct when he says: " Removal of a tubercular kidney does not always cure the tubercular cystitis."

This is the class of cases in which tuberculin combined with nitrate of silver injections from 1 : 2000 up to 1 : 1000 should be used. I have seen some very satisfactory results lately by the use of this combination.

The diagnosis of tubercular nephritis is made by finding tubercle bacilli in the urine. As Armstrong of Montreal says, we must have pus as well as tubercle bacilli in acid urine, because occasionally in pulmonary tuberculosis tubercle bacilli without pus may be found, while at autopsy no disease of the kidney exists to explain its presence. It is often difficult or even impossible to find tubercle bacilli in a single small specimen of urine, but if all the urine passed in 24 hours is first sedimentated and then stained, tubercle bacilli can usually be found if present, and, on the other hand, if this is done and no tubercle bacilli are found, we can rule out tubercular nephritis with almost absolute certainty. Tubercle bacilli are very much more apt to be found in the urine either with or just after the passage of blood according to Tilden Brown, or

in the urine containing thick purulent particles according to Newman.

The teaching of a couple of years ago that tubercular nephritis could be diagnosed with certainty from the gross appearance of the ureter openings as seen through the cystoscope is now disproved. When the ureteral orifice is ulcerated, showing miliary tubercles on its edges, or assumes the golf-hole appearance, we can usually presume that this is a markedly diseased kidney. But occasionally the ulceration is not about the ureter and may even be on the opposite side of the bladder, so that the only sure and safe method is to catheterize both ureters, which although sometimes difficult is usually possible, and then stain the sedimental from both specimens.

In regard to the catheterization of the ureters, the bladder is occasionally so ulcerated and inflamed that the ureteral openings cannot be seen at all. In such a case recently at the University Hospital (Case VII of the list), my assistant, Dr. Strackhauer, had to make several injections of 1 : 1000 nitrate of silver solution. At the end of two weeks the bladder inflammation had sufficiently subsided to allow catheterization of the ureters. Such a preliminary course of treatment seems to assure a quicker cure of the cystitis after operation. The hypodermic injection of methylene blue, which Dr. Strackhauer used on this case, noting through the cystoscope the length of time which it takes to be excreted (five minutes in a healthy kidney, 10 to 15 in a diseased one), and the stream not being a bright blue but more muddy in character, proved to be a marked help in deciding the point of function by this diseased kidney.

Kummell makes a strong plea for the examination of the freezing point of blood in these cases. The normal freezing point is 0.56 to 0.57. If the freezing point is 0.6, nephrectomy ought not to be done; but instead we should open and explore the kidney, letting out the pus and removing the worst of the disease. Then tampon the divided kidney with gauze. After a few days the other or better of the two kidneys may improve enough to take up the bulk of the work. We will usually find

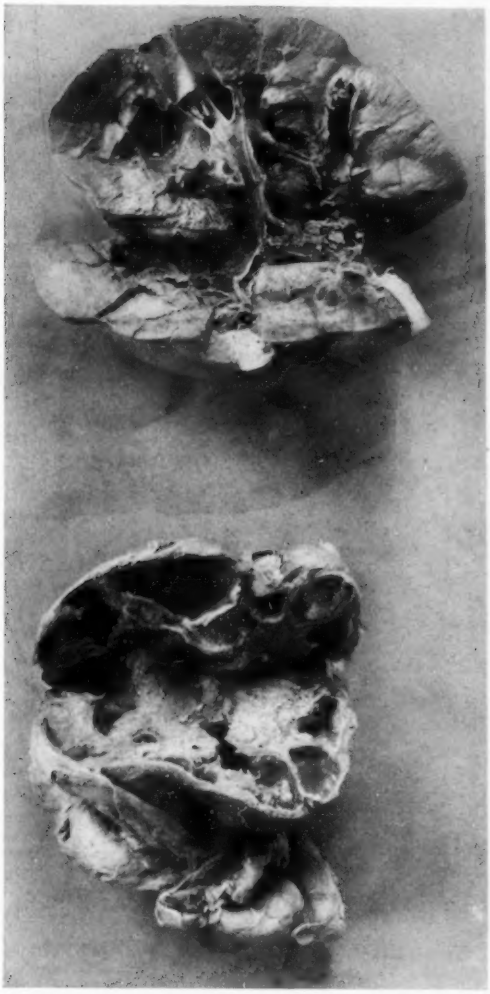
that the freezing point of blood has come back to normal, and then it will be safe to remove the diseased or divided kidney.

Nature occasionally cures one of these badly diseased kidneys by stricturing its ureter and shutting it up within itself, autonephrectomy as it has been called. These patients are seldom well. They are more or less uncomfortable, having indefinite abdominal pains and occasionally some bladder distress, from a slight leakage, no doubt, from the partially closed ureter.

Several years ago, before we were able to use the male cystoscope, a physician friend of mine brought me his brother, who was supposed to be suffering from left kidney stone. We had no male cystoscope nor X-ray machine capable of taking a kidney stone picture, as he had suffered from several marked attacks of left kidney colic, associated with the passage of blood with the urine, the abdomen was opened for the purpose of determining the presence of the right kidney. This seemed to be of normal size and consistency. The left kidney was opened; a good sized tubercular abscess filled the upper pole with a smaller abscess in the lower pole. There were also several cheesy masses ready to break down and many miliary tubercles scattered all through the organ. A resection did not seem advisable, so the left kidney was removed. This man lived ten days, only passing two ounces of watery, pusy, thin fluid in all of that time, and the autopsy showed that the right kidney was a solid cheesy mass, with practically no kidney tissue left. Fig. 1 shows the photograph of both kidneys.

The kidney, pelvis, and ureters are often found very much diseased, the ureter being sometimes as thick as the index-finger from tubercular induration. It has been my custom for several years to remove the ureter down to the pelvic brim, according to the advice of Howard Kelly. In a recent case at the University Hospital (Case VII), there was a slow chronic abscess which persisted about the stump of the ureter and eventually wore the poor woman out, over two months after her nephrectomy and long after the wicked tubercular cystitis had disappeared. Since this experience I have adopted Mayo's plan of injecting the stump of the ureter with 20 drops of pure

FIG. 1.



The upper specimen is of the left kidney showing cavities of tubercular abscesses opening into the pelvis. The lower specimen is of the diseased kidney removed at post-mortem. Most of the cheesy masses have been removed but there was no normal kidney substance left.

FIG. 2.

Case III.

FIG. 3.

Case VI.

FIG. 4.

Case VIII.

carbolic acid, ligating and dropping the ureter into the wound.

In regard to the operation itself, we have found that Mayo's incision, especially for the left kidney, helped very much in exposing the high lying kidney and its pedicle, and that the curved kidney clamps of Styles help to prevent the slipping of the pedicle, with its startling and tremendous hemorrhage which sometimes occurs. If the ligature should slip or the clamp not hold the renal artery, the hand is the best tampon. One can feel the pulsating artery very distinctly, and with the finger, if necessary, by the sense of feeling alone can seize the artery with forceps and then easily ligate it with heavy catgut. The renal vein should be separated from the artery and ligated by itself. The ureter should never be ligated in a mass with the vessels, as this predisposes to secondary hemorrhage.

CASE I.—A boy of ten years came to my service at the University Hospital last March with frequent and painful urination, having to urinate every 15 minutes. This symptom was first noted last September. He was put to bed for two months; became worse as soon as he commenced to be about again; soon had pain at the end of urination and nocturnal incontinence. Two weeks before coming to the hospital, first noticed blood in the urine.

Pathology.—Examination of the urine showed a large number of tubercle bacilli. Cystoscopic examination, by Drs. Strackhauer and Ritchie, showed marked ulceration about both ureteral openings with discharge of turbid urine from both ureters. The catheterized specimens showed abundant albumin, pus, and tubercle bacilli; occasional red blood-cells; no casts. Hæmoglobin was 75 per cent.; leucocytes 7300; differential count 50 per cent.; lymphocytes 38.4; polymorphonuclears, 6.8 per cent. large morphonuclears. Temperature occasionally ran 99.2° in the afternoons and pulse occasionally to 120. This boy did not look tubercular, but was of good color and robust in appearance.

No operation was done, but he was turned over to the medical service and is markedly improved in every way, although he still has some bladder disturbance. The tubercle bacilli in his urine have markedly decreased.

CASE II.—(To prove how perfectly these people may recover

after the removal of a badly diseased kidney.) (Surgical case No. 1914.) Mrs. W. L., case of Dr. McKay, Bottineau, North Dakota, age twenty-seven years; married one year; never pregnant; urine thick for two years; pain in back and commenced to fail two years ago; first noticed lump in left side five weeks ago; tubercle bacilli found in urine December 7, 1903.

Pathology.—Tuberculosis with destruction of almost entire left kidney; one ounce of thick, cheesy, offensive pus; cheesy nodules in parenchyma; no apparent disease of the ureter.

Operation.—Exploratory laparotomy showed a few old omental adhesions; right kidney normal; uterus and appendages normal; nephrectomy; difficult removal of large kidney; ruptured during removal.

Result.—Recovered. January 28, 1904, gained 29 pounds. May 15, 1904, weight 125 pounds. October 20, 1904, pus in urine, many tubercle bacilli. December 9, 1905, looks and feels well; two months' pregnant. Baby born safely June 24, 1909. December 29, 1909, mother and baby well. Mother and child still well.

CASE III (Surgical case No. 3576).—Ed. L., case of Dr. Sherman, Luverne, Minn., age thirty-five; hip disease at 12 years of age; in bed 13 months; abscess and removal of left testicle five years ago; pain in right kidney and chronic cystitis for the past four years. Many tubercle bacilli found in the urine.

Pathology.—Cystoscopic examination made by Dr. H. P. Ritchie, who found tuberculous bladder about right ureteral opening; clear urine from left.

Operation.—Nephrectomy difficult, because small kidney highly placed; rib divided; pedicle slipped, caught with difficulty. For examination of specimen see Fig. 2. On section large abscesses throughout entire kidney. The only portion of normal tissue is at the upper pole. Largest tubercular abscess opening into the pelvis in the lower pole.

Result.—Primary wound union. Recovered. Ten days after operation, wound opened and serous discharge; temperature and pulse normal. May 16, 1912, Dr. Sherman writes that this man is very much alive and is to all appearance enjoying very good health; for a long time he has not complained at all, attending his business every day. Gained 20 pounds in weight.

CASE IV (Surgical case No. 2921).—Mrs. Gilbert A. W., case of Dr. H. Davis; age thirty-five; three children; persistent bladder

distress for past six months. Tubercle bacilli in urine. Cystoscopy by Dr. H. P. Ritchie showed ulcer at left ureteral opening of bladder; pain in left kidney.

Pathology.—Tubercular nephritis and ureteritis; caseous masses in the kidney; miliary tubercles all through; very little normal tissue left; several abscess cavities opening into pelvis of kidney.

Operation (St. Luke's Hospital, January 2, 1908).—Nephrectomy and removal of eight inches of ureter; two gauze drains, one down to stump of ureter. Immediate result: no diminution in amount of urine; bladder distress much improved; slight wound infection. Two months after operation urine better, up two or three times in the night; some discharge from the sinus, two inches deep. April 30, urine normal; sinus three inches deep; gaining weight.

Second Operation (St. Luke's, August 8, 1908).—Sinus still open and discharging pus; gained 25 pounds in weight; no pain.

Pathology.—Tuberculosis of a stump of ureter; bismuth mixture injections has produced no effect.

Operation.—Curettement; tubercle bacilli, granulation tissue; cavity two inches deep.

Result.—August 17, 1908, skin edges still open. Later injections of bismuth paste very little result. February 26, 1909, sinus closed. Last report, May 13, 1912. Patient perfectly well; no trouble with bladder or old sinus; has gained 35 pounds since her operation.

Case V (Surgical case No. 3640).—Mrs. L. M. I., age forty-eight; sick for five years; nervous prostration, and chronic cystitis; pain in left kidney. Cystoscopic examination by Dr. H. P. Ritchie. Typical tubercular ulceration about right ureter; left ureteral opening normal; left ureteral catheterization one ounce in six minutes, of clear normal urine, no urine from the right ureter. Tubercular nephritis; kidney completely destroyed; one cyst containing watery fluid; rest, cheesy masses.

Operation (St. Luke's Hospital, January 5, 1910).—Nephrectomy; one week after operation patient much better; bladder distress and pain in right side gone.

Result.—Recovered. March 10, 1911, bladder distress returned and is as bad as ever. Incontinence at night; some hemorrhages; quinine and sulphate irrigations, alternating with silver

solution, antiseptic and supportive treatment for one year, with gradual improvement. At present date Dr. Ritchie says that she is perfectly well, weight gained, and comfortable; urinalysis reveals some pus and albumin, but no tubercular bacilli found in present examination.

CASE VI (Fig. 3) (Surgical case No. 3811).—Mrs. A. T., case of Dr. Daigneau, Austin; age forty-four; quite well until two years ago, following violent exertion, nervous prostration, with frequent and painful urination; often every 15 minutes during the day. Past two months relieved by bladder irrigation. Cystoscopic examination by Dr. Ritchie revealed marked tubercular ulceration about the left ureter; tubercle bacilli from catheterized specimen.

Pathology.—Left tubercular nephritis, one large abscess at lower pole, almost broken through the kidney capsule, opening into pelvis of kidney.

Operation (St. Luke's Hospital, September 26, 1911).—Nephrectomy; kidney and eight inches of enlarged, thickened ureter removed; a number of small abscesses in median portion; nodules and caseated areas scattered throughout.

Result.—Bladder distress and temperature gone next morning; returned in two or three days. Recovered. February 1, 1912, bladder distress marked. Cystoscopy showed inflamed base; irrigation of 1:1000 nitrate; relieved. May 16, 1912, Dr. Daigneau writes patient is still uncomfortable, but much better and improving.

CASE VII (University Hospital).—Mrs. M. D., age fifty-six years; married; father died at seventy-eight of pneumonia; mother died at thirty-six of "quick consumption"; three brothers and sisters living and well. Had seven children, all but two being dead. One died of consumption at 16; one of pneumonia at 14; one of pleurisy at 27; two died in infancy. Patient was admitted to University Hospital December 11, 1911, complaining of painful and frequent urination, pain being most marked at end of urination; foul-smelling vaginal discharge between times accompanied by "bearing down" pains in pelvis, and some backache.

Menstrual history negative. Menopause four years ago; childbirths normal; venereal history negative.

Personal history negative except for measles at 14, scarlet fever at 10; some leucorrhœa for past four years.

Three years ago patient noticed severe bearing down pains in lower abdomen, usually preceded by nausea and vomiting. Previous to this time patient was very well. These attacks would come at four- to six-week intervals and last a few hours. Between attacks patient would be perfectly well, but had to take to bed during the attack. Patient was seen by a doctor six weeks after the onset of attacks, who advised the taking of douches, and this brought some relief.

Three months ago after the doctor had inserted a pessary, a profuse foul-smelling pus-like discharge appeared in the vagina, which lasted one day. After this, discharge would appear at three- to four-day intervals, succeeded by numbness and a sense of weight in the pelvis.

Two months ago patient experienced for the first time a severe lancinating pain in the urethra at the end of micturition. On a number of occasions blood or bloody shreds were present in the urine. This has been getting progressively worse. There has been an increase in the frequency of urination for the past two years and now it is on the average of about seven times during the day and three to four times during the night. The total quantity of urine passed has not been increased.

The patient is a well-developed and fairly well-nourished individual. Physical examination is negative excepting for tenderness over left kidney and ureter, and over bladder. Vaginal examination revealed an infiltrated and thickened base of the bladder, exquisitely tender. Uterus not freely movable; cervix firm and bled easily on manipulation.

Cystoscopic examination on December 14 by Dr. Strackhauer showed the whole base of the bladder involved in an ulcerative inflammation, covered with pus and fibrin. Areas about the ureteral openings puffy and œdematous so that openings could not be made out. The bladder was extremely sensitive. A second cystoscopic examination on December 26, after several bladder irrigations with 1 : 1000 silver nitrate solution, showed the mucous membrane to be clearer and less deeply congested, otherwise findings were the same.

Urine examined at different times showed a moderate amount of albumin, few granular casts, and an abundance of pus-cells. On December 16, large numbers of tubercle bacilli were found in the urinary sediment. On January 9, a small shred of bladder

mucous membrane that came away in the cystoscope showed several groups of tubercle bacilli.

A quantitative used and nitrogen estimation of 24 hour specimen revealed a very low (7.96 Gm.) urea output.

Blood examination showed 80 per cent. hæmoglobin, 4,500,000 red blood-cells, and 5400 leucocytes. Temperature ranged between 97° and 98.6°, pulse 56 to 80, respiration 16 to 20.

A diagnosis of tuberculosis of the left kidney with a tubercular cystitis was made, and I performed a nephrectomy on January 16, 1912. The kidney was found adherent to capsule, with miliary tubercles on surface. Thickened ureter as far down as crest of ilium was removed.

Patient rallied from operation fairly well, but afternoon temperature began to appear, rising from 101° to 103°; morning temperature 99° to 100°.

In the early part of March patient began to display signs of gradual decline. A secondary operation to improve the drainage was performed on March 19, 1912, and a drainage tube inserted down to stump of ureter. Patient began to decline rapidly, however, and died March 22, 1912.

The excised kidney showed several nodules about 3 cm. in diameter, which on section were found to be tuberculous abscesses. A number of small abscesses and pin-head nodules were present throughout kidney substance. Cortex of kidney narrow, pyramidal; markings indistinct. Pelvis of kidney and ureter also showed nodules.

CASE VIII (Fig. 4) (Surgical case No. 3920).—E. H., case of Dr. Hopkins, Cumberland, Wis.; age twenty-six. Middle of last July commenced to have pain at end of micturition, with a drop or two of bright red blood after each passage of urine. This continued for two weeks. At present he is very tender over the left kidney, but no discharge of blood for past two months, but complains of frequent attacks of shooting pain into left testicle.

Cystoscopic examination by Dr. H. P. Ritchie showed clear urine from the right ureter, but an intensely inflamed condition of the left ureteral opening. Many tubercle bacilli were found in the urine from the left catheter; none from the right.

Pathology.—Tubercular nephritis; three large sized distinct abscesses in cortex of kidney; few miliary cheesy nodules.

Operation (St. Luke's Hospital, March 29, 1912).—Mayo incision, separating lower left rib; nephrectomy; vessels and upper end of ureters ligated with double No. 3 catgut.

Result.—Primary wound union. Recovered. April 11, 1912, has had mild temperature; no bladder distress; no tubercle bacilli in urine. Wound opened up after reaching home, but looked and felt well.

CASE IX (Surgical Case No. 3933).—O. G., Buffalo, Minn., male, age thirty-seven; single; farmer. Family history negative. Patient admitted to the University Hospital March 19, 1912, complaining of very frequent urination, with pain at the end of the act, with occasional presence of blood in the urine.

About a year ago patient noticed some pain in upper left inguinal region and in a less degree on right side. This pain was increased by hard work, especially by lifting. The pain would often localize itself in left sacro-iliac joint and be very sharp in character. About three months ago patient was suddenly seized with a sharp pain in the suprapubic region. This condition grew progressively worse, up to the present time, and urination became more frequent. Six weeks ago, patient noticed that in the early morning urine the first portion passed would be cloudy, then clear, and the last contained blood. At times the pain after urination would last for three-quarters of an hour. General health remained good. Exertion or stooping over brought on the pain in left lumbar region.

Patient was a very well-developed and well-nourished individual. Physical examination revealed nothing abnormal except for tenderness over the bladder region.

General urine examination showed abundant albumin, no casts, numerous leucocytes and red blood-cells; a stained sedimentated specimen showed large number of clumps of tubercle bacilli.

Cystoscopic examination by Dr. Strackhauer on April 1 revealed a number of small ulcers distributed over the base of the bladder; right ureteral orifice apparently normal. An ulcer the size of a hazel-nut present at right of left ureteral orifice, and many tubercle bacilli in catheterized specimen from the left kidney; none from the right.

Blood findings were: hæmoglobin 85 per cent.; leucocytes 7300. Differential count gave 34 per cent. lymphocytes; 8.4 per

cent. mononuclears; 20 per cent. transitionals; and 55.2 per cent. polymorphonuclears. Temperature, pulse, and respiration normal during stay in hospital.

When prepared for operation it was reported to the attending surgeon that there was evidence of active tuberculosis in his left apex. Examination by the medical side confirmed these findings and they advised against giving a general anæsthetic. A consultation was held by the medical staff, Drs. Moore, Law, Dennis, Hare, Strackhauer, Ritchie, and myself. It was decided, as the man had no dyspnœa or cough, that it would be better to proceed with the operation, which was performed on April 20, 1912.

Operation.—Removal of the kidney. There was considerable hemorrhage from the slipping of the clamp. The man stood the operation well, but had a mild wound infection. He is still in the hospital but rapidly improving and quite out of danger.

THE TOMATO JOINT.*

BY ROBERT W. JOHNSON, M.D.,

OF BALTIMORE.

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THIS is not a discovery, it is a reminder.

Had Mrs. Bardell, instead of Mrs. Leo Hunter, said to Mr. Pickwick, "I must make you promise not to stir from my side the whole day," she could not have taken a more secure way of enforcing his presence than to fill out the famous menu emphasized by Sargeant Buzfuz at the notorious trial.

"Chops and tomato sauce, yours, Pickwick; chops! gracious heavens! and tomato sauce!" The great novelist, true to nature, though possibly wrong in his pathology, elsewhere states "Mr. Pickwick was laid up with an attack of rheumatism." Mr. Weller, Sr., rushes in where angels almost fear to tread, with his diagnosis and treatment of gout as follows:

"The gout is a complaint as arises from too much ease and comfort. If you're attacked with gout, sir, jist you marry a widder as has got a good loud woice with a decent notion of usin' it and you'll never have the gout again. It's a capital prescription, sir, I takes it regular and I can warrant it to drive away any illness as is caused by too much jollity."

My real reason for bringing this subject before you is that frequently, especially in the autumn, we are called on to see cases of joint involvement that have all the earmarks of surgical trouble. As in the life history of hip-joint disease, there has been a fall, a twist, or bruise at some time or other, so with this joint affection and with the pertinacity of those who use psychic analysis for "psychic trauma" we can generally bring out by careful and positive (possibly leading) questioning a history of sprain or strain about the time of joint discomfort. If the knee, a favorite joint, be involved, we find it enlarged, swollen, tense, or with marked effusion but not red, painful especially on motion but the pain of rather a subacute condi-

* Read before the American Surgical Association, May 30, 1912.

tion, with slight increase of local heat. The floating patella can be made to strike the condyles, and occasionally the joint is caught in extension and with difficulty flexed, due to the displacement of its constituents by the effused fluid. If you are not the first consulted, you will find evidence of treatment dependent on the energy and ignorance of the previous attendant, and ranging all the way from the cosmetic effect of iodine to mechanical fixation in plaster. When asked if the treatment has done good, the patient affirms " not a bit," or in the words of that practical joker, Osler, who popped his head into my office one morning and told me before my waiting patients, " That trouble has all come back." I had the presence of mind to say, " You should have been ashamed to have gotten it in the first place "; but you cannot say that to these patients, for there is more obloquy to the surgeon that has treated them thus than to the sufferer himself.

I have seen some of the best and most careful men make mistakes in these cases, simply because they are not satisfied with an easy diagnosis, or get a preconceived fixed idea from the history and appearance of the joint. I will not go into the minute examination of the urine, beyond stating in a general way that it is hyperacid with marked evidence of urates in the brick-dust deposit, nor are the other signs of uric acid diathesis, as we used to call it, absent—depression, acid, dyspepsia, occasionally pruritus, and even eczema. Nor is the pain limited to joints alone, for we find it simulating intercostal neuralgia, gall-stone, podalgia, or severe pain in the fibrous tissue about the os calcis. I recall an instance which looked almost like hysteria. I was called to see a gentleman with pronounced pain in his heel, without much local evidence, and before I got home I had a similar pain that nearly kept me from walking. I recognized in both instances the cause, *i.e.*, we had both indulged in tomatoes.

When you think that there are over 288,000,000 quarts of canned tomatoes consumed in these United States a year, not to speak of the millions used in the natural state, one wonders almost that some are not drowned in the flood of acid that

engulfs the American, whether he is a boarder or a sojourner at home. In nine cases out of ten you will find on taking the history of your joint patient, or I may go farther, treating obscure indefinable aches, that the tomato is the basis for the acid condition, and if we add coffee, we can increase our percentage to 99/100. Both are so seductive,—the raw, the salad, the broiled for breakfast, the fricasseed, the baked, the soup, the sauce, the stew, etc. (I have placed them in the order of their malignancy),—really figure so in our daily lives, that modern theology might do well to substitute the tomato for the apple as Eve's most insinuating and dangerous delicacy, and fix as the French have done its appellation of *pomme d'amours* in contradistinction to our Irish friend, *pomme de terre.*

So much for the etiology and symptoms. What is the prognosis? That depends so on treatment that the personal equation of the surgeon and not the patient has to be taken into consideration. If the cause is recognized and removed, then we may look for recovery inside of 48 hours. If the surgeon thinks that the waters of Abana and Pharphar are better than lithia water, or if he thinks that the expectant plan with rest is proper, one cannot say how long it will take nature to counteract the tomato, especially if that delicacy is continued. I have never seen a case go on to suppuration, and I believe time will cause the absorption of the effusion; but why wait when the whole trouble may be cured in 24 to 48 hours by recognition of the devil that has entered into the man *via* the tomato can, and can be cast out *via* the lithia water bottle? Hence the treatment is simplicity itself. Exercise pressure and some restraint on the joint by a closely applied flannel bandage, without necessarily in all cases taking the patient off his feet, and then by means of lithia water or some such salt counteract the acid which is irritating the serous membranes, thus producing the effusion. From henceforth, tomato must be *anathema-maranatha* to that patient. Whether this is a form of gout or rheumatism, I am not prepared to say. I have reminded you of a condition we often see and sometimes misinterpret.

ACUTE INFLAMMATION OF THE LONG BONES.*

BY ROBERT G. LE CONTE, M.D.,

OF PHILADELPHIA,

Surgeon to the Pennsylvania Hospital.

I DESIRE to make a short report of some of the features developed in a study of a series of 80 cases of acute inflammation of the long bones operated upon in the Pennsylvania Hospital. All chronic cases, syphilitic, and tuberculous lesions have been eliminated.

Etiology.—At the present time many believe that trauma is hardly to be considered as a predisposing cause, but we still think that it initiates these inflammations in a large proportion of cases. Fifty of these patients, or 62 per cent., were between the age of 5 and 20 years, that is, during the period of greatest muscular activity. Sixty-five, or 81 per cent., were in males, and with the 48 histories in which there was a record of trauma, it occurred in 38, or 80 per cent.

The exciting causes are the usual organisms of suppuration. In 23 cases where a bacteriological examination of the pus was made, *Staphylococcus pyogenes aureus* was present in 13, or 56 per cent.; *Streptococcus pyogenes aureus* represented 13 per cent., and the rest were scattered.

The localization of the starting point of the lesion is very important, for it has been our experience that when the original focus has been found and all the necrosed tissue removed at the primary operation, secondary operations are very rarely required, and when required are only minor in character.

Stone, in 1907, called attention to the frequency with which bone lesions in infants and young children were found

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* Read before the American Surgical Association, May 30, 1912.

in the epiphysis, and Homans in a recent report of osteomyelitis in children under 12 years of age, found 84 per cent. of the lesions originating in the ends of the bones, *i.e.*, in or near the epiphysis. In our group of cases we find the lesion originating in the ends of bone in 50 out of 55 cases (90 per cent.) before the fusion of the epiphysis and diaphysis. In 14 cases occurring after the age of epiphyseal union, 8 (57 per cent.) were found in the end of the bones. In 11 cases we were unable to determine the origin of the lesion. It is therefore fair to assume that during infancy and childhood these suppurations nearly always originate near the epiphysis, but after this age they may occur with equal frequency in the shaft or the ends of the bone.

In a paper published a year ago, in the *Boston Medical and Surgical Journal,* we believed that the majority of the bone inflammatory lesions originated beneath the periosteum, but in a more careful study and a division of the cases into lesions originating before and after epiphyseal fusion, we find that after epiphyseal fusion a number originated beneath the periosteum and subsequently became medullary, while before this union takes place the large majority originate centrally, the pus escaping at the ends of the bone into the periosteum and surrounding tissues.

The localization of the suppurating focus to the periosteum, the cortex or medulla, is essential but more difficult. In children before the age of epiphyseal union, Homans believes that the bulk of the infections originate in the medulla, while Stone found that they rarely involved the medulla, originating in the epiphysis and then becoming subperiosteal. These cases are always acute, and unless the X-ray is taken early in the disease the origin of the primary focus is in doubt. With us the cases came under observation too late in the disease to either affirm or deny these opinions.

An analysis of our cases shows that the character of the operative treatment has a very decided effect upon the course and virulence of the disease. We have divided the cases according to their treatment into five groups:

Group I: Within 96 hours from the onset of symptoms. At the primary operation the medullary cavity was opened and all of the inflamed tissue thoroughly removed. Subsequent operations, none. One death six hours after operation from progressive septicæmia.

Group II: From four to seven days after the onset of symptoms, at the primary operation the medullary cavity was opened and a considerable portion of inflamed tissue removed.

Group III: More than seven days after the onset of symptoms. At the primary operation the medullary cavity was opened and a considerable portion of inflamed tissue removed. Where the whole of the inflammatory tissue was removed in Groups II and III no further operations were necessary.

Group IV: At primary operation only the superficial tissues and periosteum were incised and drained. Medullary cavity not opened.

Group V: At the primary operation the superficial tissues only were incised and drained. Periosteum not opened.

In the first three groups the focus of disease was found and more or less completely removed. With the delay in time of operating, there was an increase in the amount of bone destroyed, the time required for the period of repair, the number of unhealed lesions, and in the subsequent number of operations.

Drainage of Medullary Cavity at Primary Operation.	Total	Group I, within 96 Hours.	Group II, between Fourth and Seventh Days.	Group II after Seventh Day.
Total cases	27	5	8	14
Osteomyelitis local, per cent.	68	80	61	64
Osteomyelitis general, per cent.	20	0	25	35
Entire shaft destroyed, per cent.	13	0	12	28
Unhealed, per cent.	15	0	25	21
Period of repair, days..	106	64	75	180
Subsequent operation, required, per cent.	24	0	37	36
Deaths, per cent.	10	20	12	0

FIG. 1.

Acute, localized osteoperiostitis of tibia. Thickening and elevation of periosteum: rarefaction of the cortex.

FIG. 2.

Localized osteoperiostitis of tibia. Erosion of bone.

FIG. 3.

Localized osteoperiostitis of upper third of humerus. Erosion of bone; thickening of the periosteum.

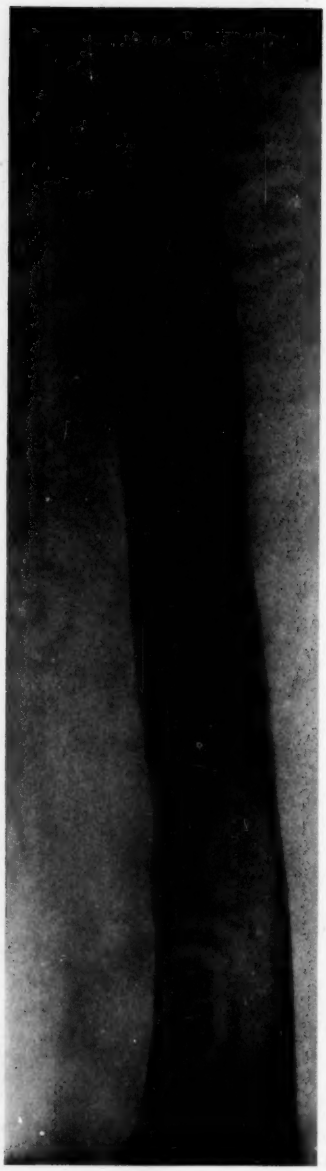
FIG. 4.

Localized osteoperiostitis of tibia. Thickening and elevation of periosteum; rarefaction of cortex.

FIG. 5.

Diffuse osteomyelitis of twelve years' duration.

FIG. 6.

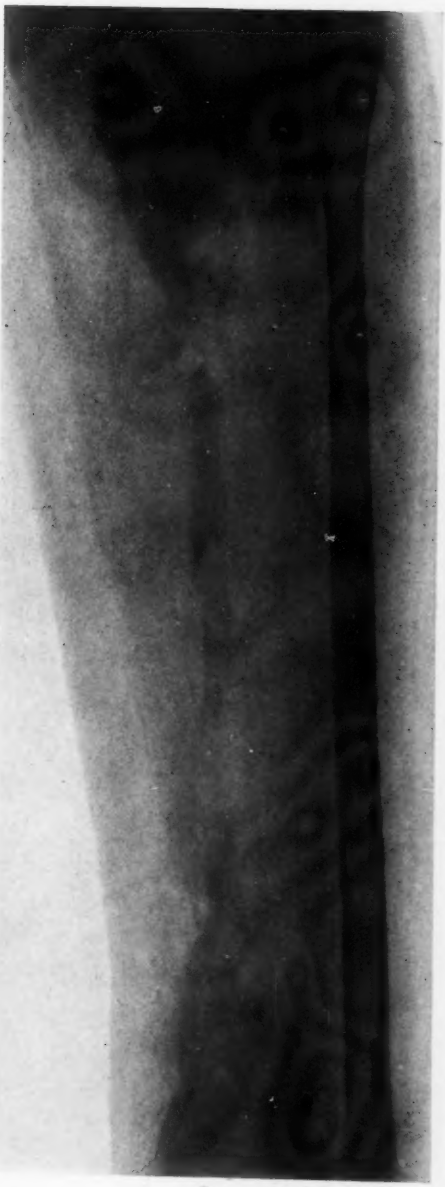


Localized osteomyelitis.

FIG. 7.

Entire diaphysis of tibia removed at operation.

FIG. 8.



Regenerating bone eight weeks after complete resection of the shaft of the tibia for acute osteomyelitis of four weeks' duration.

FIG. 9.

Same patient as Fig. 8. Regeneration of bone 12 weeks after resection.

FIG. 10.

Same patient as Figs. 8 and 9. Two fractures one year after resection of tibia. Final union.

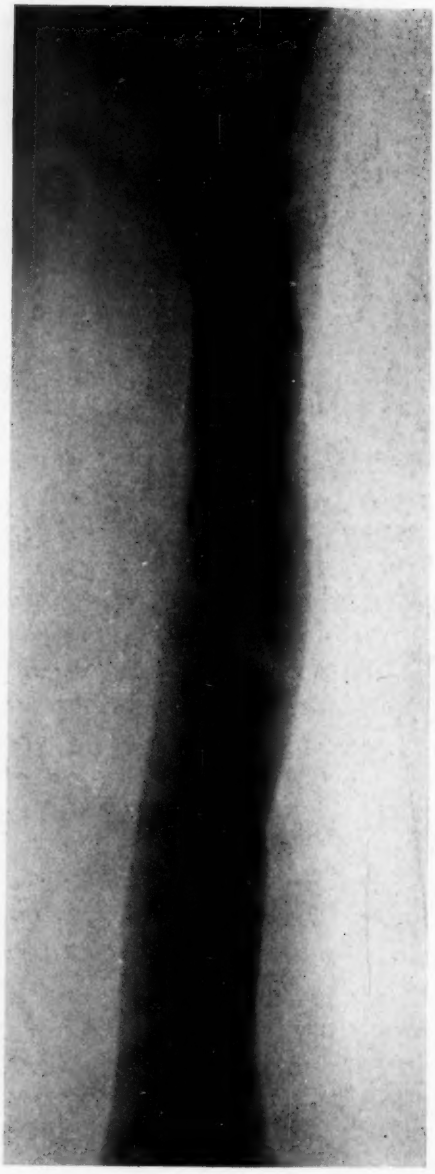
FIG. 11.

Regenerated tibia thirteen years after complete subperiosteal resection for acute osteomyelitis.

FIG. 12.

Photograph of the same patient as Fig. 11.

FIG. 13.



Regeneration one year after excision of the upper three-fourths of the humerus.

The influence of the character of the operation is still more striking by comparing the totals of Groups I, II and III, in which a more or less ideal operation was done,with Groups IV and V of incomplete surgery.

	Groups I, II and III, Drainage of Medullary Cavity	Group IV, Drainage of Periosteum	Group V, Drainage of Superficial Tissues
Total	27	20	33
Osteoperiostitis, per cent.	0	10	9
Osteomyelitis, local, per cent.	68	35	31
Osteomyelitis, general, per cent.	20	45	30
Entire shaft destroyed, per cent.	13	35	18
Unhealed, per cent.	15	25	24
Period of repair, days	106	116	250
Subsequent operation required, per cent.	24	175	160
Deaths, per cent.	7.4	10	9

In many of the cases of Groups IV and V, if not in all of them, the medullary cavity was involved at the time of the primary operation but was not opened, as the operator, finding a considerable subperiosteal abscess or abscess of the soft tissues, was satisfied with draining it. The original focus of infection was therefore not touched at the primary operation. It must be remembered that superficial lesions of the soft tissues or beneath the periosteum do not exclude a medullary involvement, for the infection often is so virulent that periosteum, cortex, and medulla are all involved as early as 72 hours after the onset of symptoms. When we find pus in the soft tissues the periosteum must be explored, and when pus is found beneath it, the medullary cavity should always be opened, if four days have elapsed since the onset of symptoms. In two cases we found the medulla healthy and no infection of the medullary cavity took place as a result of opening it.

A study of these cases emphasizes clearly to us two points in the treatment: the necessity of a prompt operation with adequate drainage of the primary focus of infection, and the removal of all diseased bone at the primary operation, even if that removal entails a more or less complete excision or resec-

tion of the shaft. We have found there is no point so early in the disease that the periosteum fails to reproduce the bone removed, but at a later time, somewhere between six months and a year, the reproductive power of the periosteum is exhausted and it fails to regenerate bone. When the condition of the patient warrants it at the primary operation, radical treatment greatly shortens the time of convalescence, prevents further destruction of bone, lessens the subsequent number of operations, and reduces the mortality.

SURGERY OF THE LONG BONES.*

BY JAMES E. MOORE, M.D.,
OF MINNEAPOLIS.
Professor of Surgery in the University of Minnesota.

THE most interesting phase of the surgery of bones at the present time is the treatment of fractures through open wound. It has already an established place in surgery but its limitations are not yet clearly defined. The tendency at the present time is to overdo and to operate upon some patients who would have good results without operation, and we have no moral right to change a simple into a compound fracture except when the welfare of the patient demands it. I am confident, however, that as our experience increases even the most conservative surgeon will employ it in some cases not now considered suitable.

The Lane plate is doubtless the best device for fixing fragments through open wound. The clavicle is not well adapted to the use of the plate because of its shape and because it is too close to the surface. A bone so shaped or a fracture so located that only one screw can be placed in one end of the plate is not well adapted to the use of the plate, because the one screw so frequently fails to hold. Most of the plates I have been obliged to remove after my own and other surgeons' operations have been very close to the surface. In one case in which I used a plate for a fractured clavicle satisfactory union was secured but the plate had to be removed later because the one screw had loosened and was causing pain. In most cases where it becomes necessary to remove the plate it has already performed its function and bony union secured, so that the mere fact of its having to be removed does not militate against the operation. In no single instance have I known the use of the plate to be followed by disaster. Had I

* Read before the American Surgical Association, May 30, 1912.

used silver wire in my clavicle case the patient doubtless would have been saved the second operation but he could not have had a better result.

Our greatest disappointment in the use of the plate is in compound fractures, for these are the very cases in which it would be most helpful, but the lowered vitality of the tissues caused by the accident prevents them from healing over a foreign body and infection, the greatest danger in compound fractures, occurs more frequently when plates are used. The wound will sometimes heal over the plate after an infection. It is a very common experience to have some serum escape from the wound after introducing a plate and still have the wound heal kindly. I placed a plate upon the radius of one patient who had been treated for a comminuted fracture of both bones of the forearm. The ulna was well united in good position but was shortened. The radius was united with a very large callus and a pronounced bowing outward. The surplus callus was removed, the radius shortened and straightened, and the plate fastened to the outer side with four screws. The wound healed promptly. A plaster splint was applied and the patient allowed to go home. Several weeks afterward the patient wrote to me that the wound had opened. Three months after the operation he came back with an open suppurating wound, a loose plate and an ununited fracture. The plate was removed, the wound thoroughly mopped with iodine, the ends of the fragments freshened and another plate immediately applied to the dorsum of the radius. The wound suppurated very freely but drainage was good, so that the patient suffered no serious effects. At the end of three weeks the patient went home with the wound all healed but one small sinus. After two months the patient returned with firm bony union, but the sinus still remains. The mere presence of a sinus is not a positive indication for the removal of a plate, for it will often close with injections of bismuth paste or balsam of Peru.

The most unpromising cases are those ununited fractures where for reasons unknown the patient fails to produce

osteoblasts and no callus is formed. I have secured bony union in one such case at the end of six months by the use of Lane's plates. The use of a bone splint taken from the patient's own person, so ably advocated by Murphy, is doubtless our best resource in these cases.

The greatest advance in the surgery of the long bones in recent years is in the treatment of fractures of the neck of the femur. It has been clearly demonstrated that our former reasons for non-union of the neck of the femur were fallacious, and that the principal reason is that the fragments have not been properly reduced and held in place. Since December, 1903, I have employed the two-way pull of Maxwell, and in only one instance where a 93-year-old patient died, have I failed to secure bony union, and in one of my patients the dressing was not applied until four weeks after the accident. With the exception of those rare cases where the joint capsule is torn and prevents reduction of the fragments, fractures of the neck of the femur can be treated with as great assurance of bony union as can fracture of the shaft. Fig. 1 illustrates the principle of Maxwell's dressing. The usual Buck's extension is applied and an additional pull of twelve or fifteen pounds upward and outward at an angle of forty-five degrees, so that the resultant of the two pulls is in the direction of the long axis of the neck. This draws the large fragment outward, making the capsule of the joint taut in the form of a hollow cylinder. The short fragment is attached by the ligamentum teres at its proximal end with the distal end floating free within the capsule, so that when the capsule is drawn taut the fractured surfaces are brought together and held there.

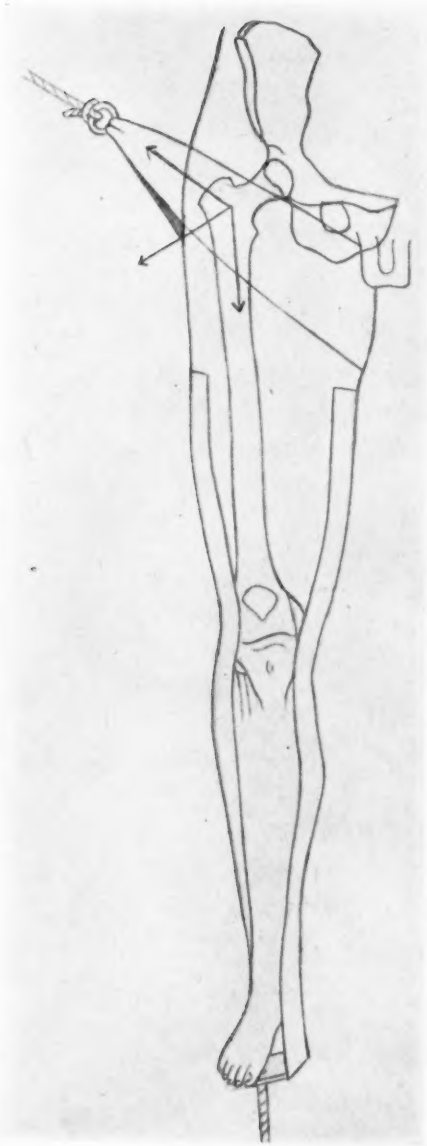
Another fallacy connected with fractures of the femoral neck is the belief that it is confined to old people. Since my attention was called to this matter by Whitman I have seen several cases of fracture of the neck of the femur in children. They are often of the green stick variety, and at first are treated as sprains or contusions and later as cases of coxa vara. Whitman's treatment by a plaster of Paris splint with

the limb in extreme abduction is simple, comfortable and efficient.

Notwithstanding the fact that the Maxwell and the Whitman methods of successfully treating fractures of the neck of the femur have been taught for years, a great many, I fear the majority, are still being treated by the old methods, the usual result being non-union. But even then all hope is not lost, for when the patient is not too old the fracture can be successfully treated through open wound. Fig. 2 is from a skiagraph of a hip I operated upon two and a half years after the accident. By sawing off the great trochanter and turning it up, the joint can be readily exposed, the broken surfaces freshened and the fragments nailed together. The trochanter is then nailed in place and the usual dressing applied. Extension is not necessary after the operation, as the nails together with the splint are sufficient to retain the fragments in place.

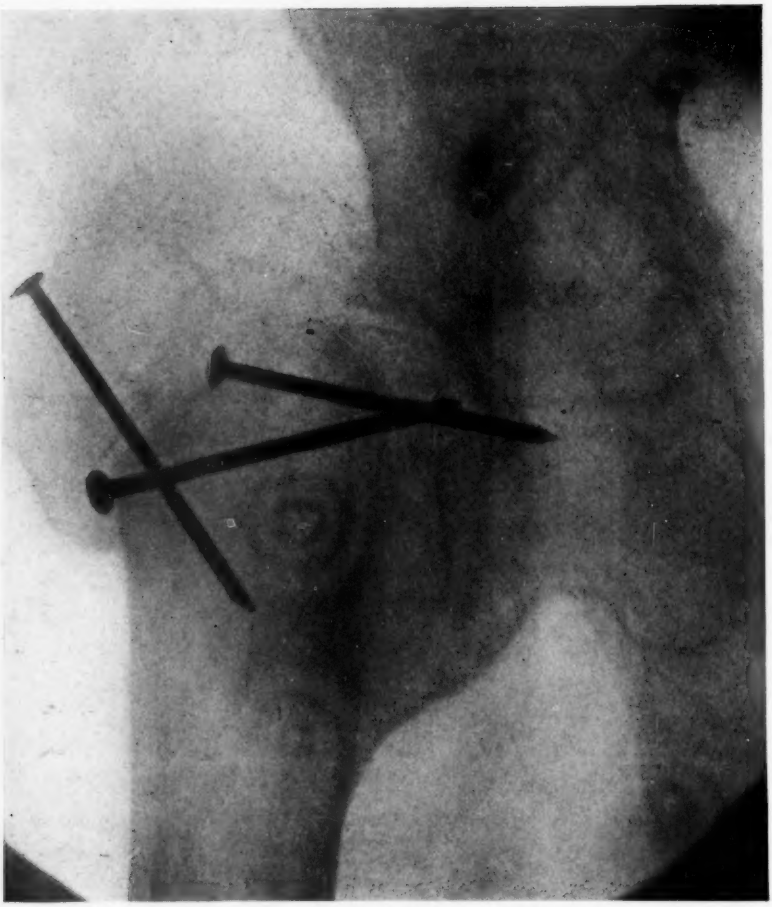
Osteomyelitis furnishes a large percentage of surgery of the long bones, and since I have learned to use the Moorhof bone wax these cases are among the most satisfactory in my practice. Notwithstanding the fact that every teacher of surgery lays special stress upon the early diagnosis and prompt operative treatment of osteomyelitis, these cases are very commonly treated as rheumatism until the time for stopping the ravages of the disease has gone by, and the consequence is that we are called upon to remedy the mischief done by the disease much more frequently than we are to operate for the relief of the disease itself. Unfortunately when the diagnosis is made the operator is too often content to cut down to the bone evacuating the secondary outside abscess without opening the medulla. This does not relieve the internal pressure and the necrotic process goes on inside. Another very common mistake is to make too small an opening into the bone. A small drill or trephine hole is rarely sufficient. A liberal opening should be chiselled through the compact tissue of the bone and moist dressings applied. Nichols made the important suggestion that the infected medulla should not be curetted out, as this destroys much bone producing tissue and it is

FIG. 1.



The two-way pull in treating fracture of the neck of the femur (Maxwell).

FIG. 2.



Fracture of the neck of the femur secured by nails.

FIG. 3.

Repair after fracture of neck of humerus complicating osteomyelitis: sequestrum removed.

unnecessary because when the hard shell of the bone is thoroughly opened nature will do the rest. It is astonishing how some of these cases are neglected. I recently operated upon a patient in the University Hospital who had evidently been suffering from an abscess in his tibia for twenty-eight years.

The old operation for the removal of a sequestrum where the cavity was packed and repacked indefinitely with gauze was very trying to both patient and surgeon. The treatment was very tedious, very painful to the patient, and always left a very unsightly scar. You will pardon me, I am sure, for going a little into detail of the technic for the use of the bone wax, for many failures have been reported after its use and these failures surely must have been due to faulty technic, for in my practice and in the practice of other surgeons with which I am familiar it is an undoubted and even brilliant success. During the operation the Esmarch bandage should always be used, otherwise the patient may lose too much blood. I have known one patient to bleed to death from the lack of this precaution. Where the soft parts are healthy so that complete primary union may be hoped for, the bandage should be removed after the sequestrum has been removed and the cavity sterilized, and the oozing controlled by hot water or hot air until the cavity is thoroughly dry before the wax is introduced. While the circulation is cut off by the bandage the cavity may be sterilized by filling it with carbolic acid and allowing it to remain from three to five minutes, after which it should be mopped out and the cavity repeatedly washed with alcohol. This is perfectly safe because no absorption can take place while the bandage is applied. Great care should be exercised to protect the soft parts from the acid, as it will cause a layer of necrosis which will interfere with union. Some of the reported failures were doubtless due to a neglect of this precaution.

In cases where the soft parts are blue, or made up partly of scar tissue, primary union throughout can not be hoped for, and the wax may be introduced before removing the Esmarch as this will materially shorten the operation. The sharp edges

of the bone on either side of the groove should be chiselled off to prevent pressure necrosis of the flaps. The cavity should be thoroughly dried before introducing the wax. Moorhof used a special hot air blast for this purpose, but the evaporation of the alcohol is usually sufficient. The drying may be hastened by introducing the electric cautery blade into the cavity, being careful not to bring it in contact with the bone so as to cause necrosis. After the cavity is sterilized and dried the limb should be held horizontal and the melted wax poured in or injected with a syringe, care being exercised that it is not hot enough to damage the tissues. The periosteum is then closed over the wax by a running suture of chromicised catgut. The integument is then closed with a running suture of iodized catgut. I have found it expedient to introduce a few interrupted stay stitches of silkworm gut, as the catgut sometimes absorbs too soon, allowing the wound to gape. These stay stitches can often be left for a month without causing harm. A liberal dressing of dry sterile gauze is next applied and held in place by a snug roller bandage, over which a plaster of Paris bandage is applied. In cases where the soft parts are healthy this dressing may be allowed to remain from two to four weeks, when the wound will often be found completely healed. Not infrequently one or more sinuses will remain for a time, through which serum colored yellow from the iodoform, will drain, but if kept sterile they will eventually heal. After a number of months, depending upon the size of the cavity, the wax is absorbed and replaced by bone. When the soft parts are blue or partly scar tissue, the dressing should be changed in ten days or two weeks, when the wound will usually be found partly gaping, exposing the wax. The wound is dressed with sterile gauze impregnated with balsam of Peru, and it will gradually heal over. This process is usually somewhat tedious, but the patient is perfectly comfortable and can often use the limb while the healing process is going on. The wax will sometimes work out in these open cases, but so long as the wound is kept sterile more melted wax can be poured in. Even in these

open cases the patients are so much more comfortable and the time of healing so much shorter than after the old packing method that there is no comparison.

When a pathologic fracture occurs from osteomyelitis the periosteum is usually preserved and nature will bring about a cure if the sequestrum is removed and the limb properly cared for.

This picture (Fig. 3) is from skiagraph of a boy's humerus, showing complete restoration of bone of normal size and shape, after a pathologic fracture and removal of a sequestrum consisting of an inch and a half of the whole circumference of the shaft.

I have found the bone wax very useful in complete excision of the elbow. The cavity is completely filled with the wax which remains long enough to prevent the bones from coming in contact, and being surrounded by soft parts is gradually absorbed and replaced by connective tissue. Since I have used the wax in these cases my patients have been more comfortable and have obtained better results than formerly. There is quite a free oozing of yellow serum for a time, but the wound has always healed satisfactorily.

END RESULTS OF FRACTURE OF THE SHAFT OF THE FEMUR.*

BY WILLIAM LAWRENCE ESTES, M.D.,

OF SOUTH BETHLEHEM, PA.

Director and Surgeon in Chief of St. Luke's Hospital.

THE femur on account of its location in the skeleton, its function, and its great size produces when broken a very serious condition both as regards the immediate effect and the ulterior consequences.

The vulnerability of this largest and strongest bone of the skeleton is rather astonishing considering its great strength, but if one bears in mind its location and the almost constant exposure of this bone to injury in all kinds of strenuous manual and mechanical labor, it is not wonderful that it is so frequently fractured.

The records of St. Luke's Hospital show that of 1869 fractures of all kinds admitted into the wards 245, or 13 per cent., were fractures of the shaft of the femur; 167 were simple fractures and 78 were compound, comminuted, or complicated fractures.

The violence necessary to fracture the shaft of the femur must be very great, the consequent injury must therefore be very considerable, and the resulting condition one which deserves most careful consideration and skilful handling.

The systematic employment of radiograms to illustrate and to check the result of formal reduction of all major fractures showed such marked lack of accurate restitution of fragments in cases of apparently good restitution that the former confidence which he felt in treating a case of fractured femur was so thoroughly disturbed in the writer's case that he set about reviewing all of his own available cases and collecting the experience and results of other surgeons in regard to these

* Read before the American Surgical Association, May 30, 1912.

fractures; also to collect and to compare the results of the closed and open methods of treatment.

In judging the results of treatment of fractures of the femur one must take as a standard, either, first, good functional results alone, or, second, good function and satisfactory cosmetic results.

Both the growing estheticism of the period and the common use of radiography require one to adopt the second standard, namely, end results of fractures should be estimated by good functional and satisfactory cosmetic results.

Surgeons who assert that good functional results alone should determine the value of the treatment reason probably that the human frame readily adapts itself to conditions of acquired asymmetry. Notwithstanding some shortening, overlapping of fragments, change of the angle of support, and variation of leverage and fulcrum if the fragments are firmly united, the final result may give the patient good function, in that he can use the member without serious inconvenience and without noticeable awkwardness of station or motion. But it will require a long time for the rest of the skeleton and the muscles to adapt themselves to the changed conditions and acquire the position and habit of good function.

Good cosmetic results, by which I mean such accurate restoration of fragments to their proper positions that no deformity results, and which means good end-to-end reposition without deviation of the angle of support, will require no new habits in balancing to be learned, nor any new tricks of the muscles to be acquired in order to have the proper function of the member restored without pain or lasting discomfort.

Good cosmetic results alone will not suffice of course. I have seen cases recover with absolutely no appreciable deformity and good union but with complete paralysis of the muscles.

Notwithstanding the fact that radiograms may be misleading and inaccurate (they are practically always so when taken by inexperienced operators), they furnish at the present time, when properly taken by a qualified operator, the best guide and

indication of the relative position of fragments in cases of fractures. Also it has become the custom of patients to insist that an X-ray picture be taken of their fractures after the "setting" has been done.

It is sometimes quite impossible to convince a layman that a good functional result may be expected even if the restitution of fragments has not been accurate.

It becomes more and more important therefore for the surgeon to strive for good cosmetic as well as good functional results.

Another very important matter to determine is what standard shall be established as the criterion of good functional and cosmetic results of fractures, especially of fractures of the shaft of the femur.

The one almost universal standard hitherto has been the resulting shortening. It is a fact that none or very little shortening will result if accurate restitution has been made in cases of fractures; so shortening of any degree will indicate overlapping and illy placed fragments. But it has been incontestably shown that this standard is very inaccurate, because the lower limbs are rarely of the same length in any human being.

Drs. John B. Roberts,[1] Jarvis S. Wight,[2] Thos. G. Morton, T. W. Huntington,[3] and Algernon T. Bristow,[4] showed by careful measurements of the dried femurs of skeletons, and by measuring the two lower extremities of a large number of men that they vary from 0.1 to 3 centimetres in length in normal conditions. Spasms of the muscles, tilting of the pelvis, and flexions of the joints multiply these variations very much in cases of recent fractures, and especially after the various fixation and traction apparatus have been used for several weeks. I have measured limbs after union of fractures of the femur which showed very decided overlapping of the fragments, and by careful and repeated measurements as ordinarily prescribed and used, found very little shortening. I remember one case, a man who had two and a half inches shortening, who walked long distances without pain or inconvenience and

who undoubtedly had good function though there was marked deformity.

The methods of measuring, too, introduce very frequently serious inaccuracies. The method probably most frequently employed, viz., the distance from the anterior superior iliac spines to the tip of the internal malleolus, is only approximately accurate and is usually not properly employed. Dr. W. W. Keen suggested the proper way of taking this measurement. The point of the malleolus should be the fixed point of departure and the anterior spines should be indicated by a horizontal line drawn transversely over them. It is very important to know that the pelvis is not tilted when this measurement is taken and that the two anterior superior spines are in the same horizontal plane. Care must be taken to make no pressure on the skin over the spines because it is quite loose and slips upward easily, thus making a measurement longer than it should be. One end of the tape should be held by the tip of the thumb firmly at the middle lower rounded edge of the internal malleolus and the other carried up by the other hand of the operator and stretched over the horizontal line made over the anterior superior spine, and the reading taken without pressing on the skin at this point. This measurement should always be checked by taking other measurements, for instance, the distance from the ensiform cartilage of the sternum or from the umbilicus to the patella or internal malleolus. Dr. Gerrish recommends measuring from the incisor teeth (the patient to hold one end of the tape between his teeth) to the knee, and malleolus on either side. Respiratory movements and varying conditions of distention of the abdomen are liable to make any measurements from a point above the pelvis to the knee or malleolus inaccurate and I think should never be used alone.

Even if no or very little shortening follows these fractures, angulation, usually exhibited by eversion or inversion of the foot, very seriously interferes both with functional and cosmetic results. Also arthritides and ankyloses seriously retard or prevent complete restoration of function. Evidently the degree of shortening alone is not a competent criterion of the

completeness of recovery from these fractures. The text-books and authoritative writers are far from clearness and precision in these crucial points in regard to fractures of the femur.

In 1890 the American Surgical Association appointed a commission to determine and report what should be considered the conditions which would indicate satisfactory end results of simple fractures of the shaft of the femur.[5]

Stephen Smith was chairman of this commission and besides him the membership consisted of Drs. D. Hayes Agnew, David W. Cheever, D. E. Yandell, Chas. F. Parkes, P. S. Connor, Chas. B. De Nancrede, and Hunter McGuire.

The report of this commission summarized was as follows: (1) there must be firm bony union; (2) there must be correct axial relations of the fragments; (3) correct relations of the anterior planes of the upper and lower fragments must be maintained; (4) shortening must not exceed from one-eighth inch to one inch; (5) lameness must not result as a consequence of shortening over one inch; (6) the conditions attending the treatment, however, may prevent these satisfactory results.

Dr. Thos. W. Huntington of San Francisco, in a paper published in the ANNALS OF SURGERY, September, 1908, on "Operative Treatment of Recent Fractures of the Femoral Shaft," quotes replies to a questionaire from 92 surgeons of the United States and Canada. Of these 92 surgeons, 69 think one inch or more shortening permissible after these fractures, 19 think not more than three-quarters inch, and only four think one-half inch should be the permissible degree of shortening. Two years ago in preparing a paper on this same subject, the writer sent a list of questions in regard to these fractures to 50 surgeons of the United States and Canada, and received 25 replies. These have been recently augmented by 10 replies to late inquiries.

To the questions, first, Have you been uniformly successful in obtaining good cosmetic results in your cases, 10 answer yes, 25 answer no.

Second, What do you regard as the permissible shortening after fractures of the shaft of the femur? Answer, one-quarter, to one inch.

American surgeons evidently regard one-half inch shortening as a very good result, and as much as one and a half inches may not be regarded as a bad result. Shortening equal to one inch necessarily means inaccurate reposition of the fragments and a large overlapment of callus in order to procure firm union. This almost of a necessity contravenes the second and third requirements stated by the commission of the American Surgical Association of 1890.

It is also very important to find out whether any special apparatus, splint, or fixation device seems to be favored by the majority of surgeons, and especially whether surgeons are at present advocating the open method of treatment as a routine one in hospitals; if so, are the results of this treatment much better than the old method.

The Pennsylvania State Medical Society appointed a commission of which the writer was made chairman in 1910, consisting of Drs. Edw. Martin, J. B. Roberts, C. E. Thomson, Geo. W. Guthrie, A. R. Allen, W. S. O. Sherman, Otto Gaub, Alex. G. Fell, Walter Lathrop, and W. L. Estes, to collect reports of fractures of the shaft of the femur, to study the whole subject, and to report at the next annual meeting.

The commission collected and collated as far as the reports would permit 278 cases as follows:

1. Total cases, 278.

2. Ages: below ten years, 70; between 10 and 20 years, 43; between 20 and 50 years, 105; between 50 and 70 years, 38; between 70 and 80 years, 12; between 90 and 100 years, 1; cases not mentioned, 9.

3. Occupation: working people, 168 cases; cases not noted, 33.

4. Cause of fracture: direct violence, 83; indirect violence, 176.

5. Seat of fracture: 195 cases has this noted. Of these, upper third, 37; middle third, 106; lower third, 52.

6. Kind of fractures: simple, 245; compound, 17; compound comminuted, 2; complicated and multiple, 6.

7. Amount of shortening at time of injury (admission):

of 112 cases noted, average shortening before reduction was 1.77 inch.

8. Method of treatment: of 221 cases noted, some form of Buck's extension, 117; Scudder's splints, 24; plaster of Paris, 19; long lateral splints, 21; sand bags, 10; Hodgen's apparatus, 3; double inclined plane, 2; open method, 11; various form of splint, 3; no dressing, 1.

9. Anæsthetic: yes, 96; no, 143; 82 cases not noted.

10. Extension, average amount of weight used: of 147 cases reported, 13.2 pounds was the average.

11. Effects of reduction on shortening as determined by measurements recorded in only a few cases.

12. Amount of shortening: *a, b, c,* these were not taken as a rule; *d, e, f,* reports too few to be used on these points.

13. Length of time in bed: of 206 cases reported, average a fraction less than 7.5 weeks.

14. Length of time absent from work: of 114 cases reported, average a fraction less than 3.5 months.

15. Length of time crutches, canes, or other aids to walking were used: of 98 cases reported, average a fraction less than 9 weeks.

Note.—No. 15 was understood differently by various reporters; the answers varied very greatly.

16. Presence or absence of limp: of 202 cases reported, 163 limped.

17. Inversion or eversion of foot or tilting of pelvis, causing serious axial displacement: of 157 cases reported 136 had no axial displacement; that is, no eversion or inversion. Twenty-one cases have axial displacement, eversion or inversion.

18. Large development of callus, producing any serious inconvenience in any way: of 168 cases reported, 117 no incommoding callus. Thirty-nine cases callus which produced some disturbance.

19. How measurements were taken: of 127 cases reported, 123 measured from anterior superior spine to internal malle-

olus. Anterior superior spine to floor, 1 case; anterior superior spine to the tubercle of the tibia, 3 cases.

20. The amount of disability as estimated by: (*a*) endurance: 121 cases reported, 70 endurance good; (*b*) pain: 129 cases reported, 19 had pain; (*c*) swelling of foot or leg: of 130 cases reported, 15 had swelling; (*d*) interference with joint function: 148 cases reported, 15 had joint interference.

21. Mortality: 24 deaths, or 8.6 per cent. Cause of death: 4 pneumonia; 5 shock, aged; 1 shock and delirium, aged 64 years; 4 delirium tremens, aged; 10 various intercurrent diseases.

22. Was X-ray used: of 173 cases reported, 83 were X-rayed. What did it show as to results: 8 cases only reported good apposition without angulation. Many reporters failed to note this point, however.

Since the above report was made, the writer has collected other cases as follows:

1. Total cases, 482.

2. Ages: below ten years, 20; between 10 and 20 years, 22; between 20 and 50 years, 17; between 50 and 70 years, 17; between 70 and 90 years, none; between 90 and 100 years, none; cases not mentioned, 385.

3. Occupation: working people, 35; cases not noted, 446.

4. Cause of fracture: direct violence, 37; indirect violence, 443.

5. Seat of fracture: 83 cases has this noted; of these, upper third, 26; middle third, 41; lower third, 16.

6. Kind of fractures: simple, 463; compound, 6; compound comminuted, 6; complicated and multiple, 6.

7. Amount of shortening at time of injury (admission): of 458 cases noted, average shortening before reduction was 1 inch.

8. Method of treatment: of 190 cases noted, some form of Buck's extension, 66; plaster of Paris, 27; long lateral splints, 1; sand bags, 20; double inclined plane, 3; open method, 64; various form of splint, 9.

9. Anæsthetic: Yes, 34; no, 38; 409 cases not noted.

10. Extension, average amount of weight used: of 63 cases reported, 15 pounds was the average.

11. Effects of reduction on shortening as determined by measurements: recorded in only a few cases.

12. Amount of shortening: (*a*) 1 inch average; (*b*) ¾ inch average; (*c*) ¾ inch average; (*d*) ½ inch average; (*e*) ½ inch average; (*f*) ½ inch average.

13. Length of time in bed: of 88 cases reported, average a fraction less than 9 weeks.

14. Length of time absent from work: of 70 cases reported, average a fraction less than 2.5 months.

15. Length of time crutches, cane, or other aids to walking were used: of 81 cases reported, average a fraction less than 8 weeks.

Note.—No. 15 was understood differently by various reporters, the answers varied very greatly.

16. Presence or absence of limp: of 107 cases reported, 81 limped.

17. Inversion or eversion of foot or tilting of pelvis, causing serious axial displacement: of 463 cases reported, 370 cases had no axial displacement; that is, no eversion or inversion; 93 cases have axial displacement, eversion or inversion.

18. Large development of callus, producing any serious inconvenience in any way: of 389 cases reported, 373 cases no incommoding callus; 16 cases callus which produced some disturbance.

19. How measurements were taken: of 60 cases reported, 48 measured from anterior superior spine to internal malleolus; anterior superior spine to the tubercle of the tibia, 12.

20. The amount of disability as estimated by: (*a*) endurance: 464 cases reported, 87 endurance good; (*b*) pain: 467 cases reported, 6 had pain; (*d*) swelling of foot or leg: 418 cases reported, 6 had swelling; (*d*) interference with joint function: 459 cases reported, 8 had joint interference.

21. Mortality: 3 deaths or 0.62 per cent. Cause of death: 1 exhaustion and shock; 1 uræmia; 1 hyperthyroidism.

22. Was the X-ray used: of 72 cases reported, 47 were X-rayed. What did it show as to results: 57 cases only reported good apposition without angulation. Many reporters failed to note this point however.

Tabulated with the 278 cases of last year's commission they appear as follows:

1. Total cases, 760.

2. Ages: below 10 years, 90; between 10 and 20 years, 65; between 20 and 50 years, 122; between 50 and 70 years, 55; between 70 and 90 years, 12; between 90 and 100 years, 1; cases not mentioned, 394.

3. Occupation: working people, 203; cases not noted, 479.

4. Cause of fracture: direct violence, 120; indirect violence, 619. Some cases are not reported. Probably many reporters misunderstood.

5. Seat of fracture: 278 cases has this noted; of these upper third, 63; middle third, 147; lower third, 68.

6. Kind of fractures: simple, 708; compound, 23; compound comminuted, 8; complicated and multiple, 12 cases; 9 not noted.

7. Amount of shortening at time of injury (admission): of 570 cases noted, average shortening before reduction was 1.38 inch.

8. Method of treatment: of 401 cases noted, some form of Buck's extension, 183; Scudder's splints, 24; plaster of Paris, 46; long lateral splints, 22; sand bags, 30; Hodgen's apparatus, 3; double inclined plane, 5; open method, 75; various form of splint, 12; no dressing, 1 case.

9. Anæsthetic: yes, 130; no, 181; 409 cases not noted.

10. Extension, average amount of weight used: of 210 cases reported, 14.0 pounds was the average.

11. Effects of reduction on shortening as determined by measurements: recorded in only a few cases.

12. Amount of shortening: (*a*) 1 inch average; (*b*) ¾

inch average; (*c*) ¾ inch average; (*d*) ½ inch average; (*e*) ½ inch average; (*f*) ½ inch average.

13. Length of time in bed: of 294 cases reported, average a fraction less than 8.2 weeks.

14. Length of time absent from work: of 184 cases reported, average a fraction less than 2.7 months.

15. Length of time crutches, canes, or other aids in walking were used: of 179 cases reported, average a fraction less than 8 weeks.

Note.—No. 15 was understood differently by various reporters, the answers varied very greatly.

16. Presence or absence of limp: of 309 cases reported, 244 limped.

17. Inversion or eversion of foot or tilting of pelvis, causing serious axial displacement: of 620 cases reported, 506 had no axial displacement, that is, no eversion or inversion; 114 have axial displacement, eversion, or inversion.

18. Large development of callus, producing any serious inconvenience in any way: of 557 cases reported, 490 cases no incommoding callus; 55 cases callus which produced some disturbance.

19. How measurements were taken: of 197 cases reported, 171 measured from anterior superior spine to internal malleolus; anterior superior spine to floor, 1; anterior superior spine to the tubercle of the tibia, 15.

20. The amount of disability as estimated by (*a*) endurance: 585 cases reported, 157 endurance good; (*b*) pain: 596 cases reported, 25 had pain; (*c*) swelling of foot or leg: 548 cases reported, 21 had swelling; (*d*) interference with joint function: 607 cases reported, 23 had joint interference.

21. Mortality: 27 deaths or 3.69 per cent. Cause of death: 4 pneumonia; 5 shock, aged; 1 shock and delirium tremens, aged 64 years; 4 delirium tremens, aged; 10 various intercurrent diseases; 1 uræmia; 1 hyperthyroidism; 1 exhaustion and shock.

22. Was X-ray used: of 245 cases reported, 130 were X-rayed. What did it show as to results: 83 cases only re-

ported good apposition without angulation. Many reporters failed to note this point, however.

The writer's own cases treated in St. Luke's Hospital are 251—167 simple fractures, 84 compound, comminuted, or complicated.

Of the 167 simple fractures, 160 were discharged cured, average shortening ¾ inch, no inversion or eversion of the foot, nor was incommoding callus noted in any case. Five cases discharged from the wards with plaster splints or were treated in the outdoor department and finally cured. One case left the hospital without any union of the fragments. One case died of delirium tremens.

Of the 84 complicated cases, 63 were discharged cured, good functional results. Seven were sent to the dispensary for continuance of their treatment; were finally cured. Four sent away with apparatus, and union not complete, were lost sight of. Ten died; five of these had grave multiple injuries beside the complicated fracture of the femur, and were practically hopeless when admitted.

Not reckoning the cases of compound fractures which required operation but for which no direct fixation apparatus was used, there were 146 formal operations for the treatment of fractures by some fixation device applied directly to the bones themselves, or 7 per cent. of the fractures treated in St. Luke's Hospital. Of these 146 open cases but one died, or 0.68 per cent. This was a case of compound fracture of the forearm. It was infected before it came to the hospital and died of tetanus.

One hundred and twenty-one were cured, that is to say, their limbs were restored to good function and good cosmetic condition; two cases are marked "improved, sent to the dispensary." I presume these were also cured but I have no certain record of this.

There were 20 operations for direct fixation of fractures of the shaft of the femur. Fifteen of these cases were operations for fixation of fractures of the shaft of the femur only; 13 of these cases were cured and two improved. The two cases

marked " improved " left the hospital with some apparatus still on and were sent to the dispensary for supervision. They both made good recoveries. Two cases were operations for fixation of fractures of one femur and one humerus; both cases cured. Three cases were for fractures of one femur and one tibia, all of them cured. Eighteen were cured, two improved, no deaths.

Dr. J. B. Walker, of New York, in a personal communication informed me he had operated on 20 cases of fractured femur " with excellent results in every case." He reported no mortality.

Dr. F. W. Huntington reported seven operated cases with no death; since then he has had three more operated cases.

Dr. Sherman, of Pittsburg, reported seven cases with no death.

Dr. Vaughan, of Washington, D. C., in a personal communication reports 23 successful cases and mentions no death. These 60 cases with mine make 80 cases without a death.

While these statistics show that the mortality after open treatment of fractures need not be higher than that of the closed method, it is unquestionably true that the operations are sometimes formidable and very difficult undertakings.

The records of some other clinics do not show such favorable results however. For instance, I was informed by a leading surgeon that the mortality rate of open treatment in the clinics of a certain city was 25 per cent. This seems almost incredible, yet I think my informant was well posted and he is certainly an honest man.

A comparison with the overwhelmingly larger number of cases treated conservatively would obviously not be fair, but the records of these few operators indicate that open treatment for fracture of the femur can be done safely.

The most important matter, however, is, Do the older methods yield satisfactory results and may they be depended upon? The answer to that is, of 760 reported cases over 700 are reported to have made satisfactory recoveries.

Unfortunately, only a comparatively few of the reported

cases were checked and illustrated by radiograms. The ultimate position of the fragments was largely a matter of conjecture therefore.

As regards length of disability, there are too few operated cases to make a fair comparison.

The records of the reported cases are too irregular to satisfy many of the questions one would like to have definitely settled.

I shall therefore use the recorded cases from St. Luke's Hospital with which I am familiar. Every case of recognized fracture treated in the wards of St. Luke's Hospital the last two years has been X-rayed when the "setting" is supposed to have been accomplished, and when the union is complete. Also in nearly every case an X-ray negative is taken of the fracture before it is permanently dressed. This series of over 200 fractures shows in the radiograms what may be called perfect restitution of the fragments in less than 2 per cent., except in the operated cases.

The average shortening in completed cases of fractures of the shaft of the femur was ¾ inch.

Stiffness of the knee-joint, especially, has always occurred, but has never failed to yield to passive movements and massage.

Excessive callus and pain at the seat of the fracture has not been noted in any case of fracture of the femur.

Inversion or eversion of the foot has not occurred sufficiently to be marked or to interfere with locomotion.

Average disability 10 weeks.

In one case no union occurred. One case died.

As regards treatment, extension and counter-extension are employed in oblique fractures usually for four weeks, after this a plaster cast. We use a modification of Volkman's foot and leg splint to preserve the proper position of the foot and leg and to lessen friction of the mattress in the traction of the weight on the leg.

Apposition splints over the fracture are applied at such places as seem necessary to press the ends of the fragments into place.

Bardenheuer's transverse traction method has very rarely been used.

We prefer the early application of gypsum dressing (a cast) under complete anæsthesia for transverse fractures.

If the radiogram shows the bones in bad position, another attempt under ether is made to reduce them; if the second negative shows bad position still, the open treatment is employed.

In using traction we employ weight enough to overcome gradually the spasm and counter-pull of the muscles. In an adult from 16 to 25 pounds are necessary. Our modification of Volkman's splint makes sand bags and long lateral splints unnecessary in order to prevent inversion or eversion of the foot.

The Open Method.—In answer to direct inquiries regarding open treatment, 30 of the 35 surgeons who answered advocated this treatment early in case it was evident that proper restitution was not accomplished. Formerly surgeons advocated operative treatment only after several weeks of extension, splints, etc., failed to obtain union or satisfactory position of the fragments.

Three advocated the open treatment as the initial routine treatment. Only four surgeons were opposed to operative treatment in any case.

The writer himself operated on most of the 142 cases treated by the open method in his clinic. He has therefore had sufficient experience to know the difficulties in regard to accurate reposition and restitution of the fragments in the various kinds of fractures.

1. One difficulty, which may be removed by anæsthesia, is spasm of the muscles.

2. Another is locking of the fragments by leverage or gravity.

3. A third is the interposition of fascia, muscles, tendons, blood-vessels or nerves between the fragments. One always observes, and I have time and again pointed out to spectators and assistants, how difficult it is to disengage the ends of the

fragments from shreds of muscles and fascia which nearly always envelope them, even in an open wound. It must be quite impracticable in very many cases by the closed method.

4. The fourth difficulty is the shortening and overlapping which remains even after the spasm of the muscles which produced it is relieved by anæsthesia.

5. The last difficulty I would note is preserving the reposition of the fragments until a fixed, supporting dressing of some kind may be applied.

Difficulties numbers 1 and 2 are usually overcome by complete anæsthesia and careful manipulation.

The third difficulty, namely, covering of the ends of the fragments, and sometimes complete deviation of the fragments by some of the soft tissues, requires careful retraction, frequently curettage, always sufficient care and time completely to remove any shreds which would prevent the bones from coming actually in contact with one another. Anything which would result in the formation of fibrous tissue interposed between the ends of the fragments will jeopardize bony union and may cause a false joint.

The fourth difficulty, namely, to bring the ends of fragments into accurate apposition when they are overlapped, as they frequently are, an inch or more, usually is an extremely trying thing in the case of a fractured shaft of the femur. Manual traction on the foot and leg sometimes is quite inadequate, mechanical contrivances for traction are more efficient, but unless very carefully employed and supervised are apt to cause injury to the soft tissues to which they are applied. Direct manipulation of the fragments with Lane's forceps or Lowman's clamps without traction frequently fails. I have often used a lever after traction on the leg has drawn the lower fragment down far enough to insert the lever between the ends of the fragments. This does not control the fragments absolutely while the plate is applied, however. When the fracture is oblique the Lowman clamp is also uncertain in retaining the fragments immovably.

To overcome this difficulty, Dr. John Gerster, of New York

City, has recently devised what seems just the thing needed. It is a turnbuckle which should be used with a specially arranged pair of Lowman's clamps. These are a little heavier than the ordinary Lowman clamp and have a slot just in front of the shaft, so that a Lane or some similar plate may be slipped along the bone and adjusted over the fracture. One of the clamps should be applied to either fragment of the bone and should occupy the same relative position to each fragment.

As soon as the clamps are properly adjusted and the turnbuckle placed between them, an assistant should draw on the foot and leg, and when the end of the lower fragment is brought as far as practicable the extension is continued by means of the turnbuckle. While this makes the longitudinal adjustment, the clamps may be used to direct the lateral adjustment, or a strip of sterile gauze or bandage may be used for this purpose. This apparatus holds the fragments when adjusted rigidly in place until the plate is placed and screwed or pegged fast.

Dr. Edward Martin's suggestion of the use of a stout piece of muslin or canvas passed over the ends of the fragments for extension has the disadvantage of the likelihood of leaving shreds of cloth in the wound and over the ends of the bone; beside it requires a much larger wound to apply it than otherwise would be necessary.

The fifth difficulty may be overcome by the use of a plate placed over the fracture and secured firmly to the ends on either side.

In 1886 the writer devised a plate for direct fixation of fractured bones. It has been used in his clinic with good results ever since. It is a modification of the early Schede plate. It is made of soft steel, nickel plated. It has been known to bend a little but has never broken while in use. We use nickeled steel pegs, shouldered so as to press down firmly on the plate and hold it rigidly in place, and with a flat rectangular shaft which when in use projects through the soft tissues over the bone and by which the peg may be removed after union is sufficiently

advanced. The plate may be left indefinitely or removed at any convenient time.

Besides Lane's plates there are many other similar fixation devices. The operator may have a number from which to choose.

I must confess to a very strong dislike to any apparatus which will leave metallic substances within the bone itself. Undoubtedly it has been proved that the screws of Lane's device may remain within the lamellæ of the bone as far as the medullary cavity without producing any apparent evil. Still it must interfere with the nutrition of the bone, and to the extent that it does it proves harmful. In many instances the apparatus produces so much "irritation" long after union of the bone has occurred that it must be removed. I prefer therefore a fixation device which permits the easy removal of the screws or pegs which are driven into the bone. The plate may remain encapsulated over the periosteum without any harm.

No class of wounds or operations require such minute and complete aseptic details and preparations as these fixation operations on fresh fractures. Serious infection not only destroys the object of the operation, direct union of the bones without callus, but in every case jeopardizes the life of the patient.

The operations should be undertaken only by experienced surgeons whose aseptic technic is thorough and where all necessary instruments and apparatus may be had.

One feels confident, though surgeons have not reported except in a few instances their failures and deaths, that after these operations the percentages of deaths must be far higher than by the old conservative closed method.

SUMMARY AND CONCLUSIONS.

A study of the 760 tabulated cases of fracture of the shaft of the femur shows:

1. That records of fracture cases are kept very incompletely and that it is quite impossible in the United States

to obtain anything like full, accurate, and reliable data of a large number of finished cases.

2. The largest number of cases of fracture of the shaft of the femur occurs in men between the ages of 20 and 50 years. Children under 10 years of age have the next largest number.

3. Working people furnish the largest number of cases, though data in regard to this point are not kept in the majority of cases.

4. Indirect violence produces by far the largest number of these fractures.

5. The middle third of the bone is most frequently broken, the lower and upper thirds are almost equally involved, of the reported cases.

6. Simple fractures far outnumber the compound and complicated ones.

7. Average shortening before reduction 1.38 inch.

8. By far the most frequent method of treatment was by some form of Buck's extension.

9. An anæsthetic was not used to assist reducing the fractures in the majority of reported cases.

10. The average weight used in extension was 14 pounds. (This is too little weight.)

11. Not answered.

12. The average reported shortening of completed cases is ½ inch.

13. Average length of time in bed, 8.2 weeks.

14. Average length of time incapacitated, 2.7 months. (This is probably a mistake.)

15. Average length of time crutches, canes, or other aids in walking were used, 8 weeks.

16. Limp was present for some time in the large majority of cases.

17. A little less than a fifth of the reported cases had inversion or eversion of the foot or tilting of the pelvis from serious axial displacements.

18. A little more than a tenth of the cases had excessive callus which produced some disturbance.

19. Nearly all the reported measurements taken were from the anterior superior spine of the ilium to the internal malleolus.

20. Disability estimated by (*a*) endurance, (*b*) pain, (*c*) swelling, (*d*) interference with joint function, present in about 1 case in 25 reported.

21. Death rate of reported cases, 3.69 per cent. (This I believe is a mistake.) Chief causes of death: (*a*) pneumonia, (*b*) shock and exhaustion, (*c*) delirium tremens.

It seems to the writer that there is no reason from the study of this much larger number of cases to change the form or wording of the conclusions adopted by the Commission of the Pennsylvania State Medical Society in its report of last year, and he offers these as his present deductions.

These incomplete reports, and the comparatively large number of cases which have been tabulated serve to indicate indubitably that this most important fracture and serious injury, in hospitals at least, does not receive the attention and care of the chief surgeons as a rule. Treatment is usually delegated to the interne staff, whose experience and anatomical and mechanical knowledge are wholly inadequate to meet the indications in a great many of the cases, and whose lack of order and thoroughness makes the records of the cases such unreliable data that it is very difficult for any one searching for the truth in the various phases of treatment to find what he wishes.

The first recommendation of the writer, therefore, would be, and the first deduction from his work is, that teachers of surgery in medical schools should give far more attention than they have done in the last decade or more to their own investigation of fractures, and to the teaching of this most important branch of surgery to the students who belong to their classes.

Second, while recognizing the fact that X-ray photographs may be most misleading, the writer believes nevertheless, when taken by competent anatomists who understand the importance of proper relative position of tube and limb, and the importance of taking more than one view of the fracture, these radiograms will furnish an indication for the proper reduction, and

the mechanical appliances for the preservation of proper apposition, and that they will serve as a graphic record of the fracture itself.

These radiograms to be most valuable should be taken before reduction of the fracture, when it has been reduced and has a fixed dressing, and finally after union has taken place and the patient is able to be up and about.

In regard to the method of treatment, the writer from the study of the cases finds that some form of traction is the method most commonly employed, and that the results after such treatment in most cases enables the patient to resume his occupation and function without serious detriment. Properly taken X-ray pictures however show that absolute apposition and restoration of proper axis of the bone is very seldom accomplished.

Deaths from simple fractures of the femur are 3.69 per cent. of the cases; the reports show they occur almost wholly in cases of old age from shock and exhaustion or from pneumonia; in drinkers from delirium tremens; or from some operative interference. It is evident that the open method itself introduces into the treatment of these cases such a very marked element of danger that the writer cannot recommend the method for general use nor recognize it as a routine practice.

In selected cases where it is impracticable to restore the fragments to their proper position, and where mechanical means have failed within a reasonable time to produce proper restitution of the fragments, the open method may be employed, but then only by an experienced surgeon, one who habitually employs most thorough aseptic methods.

The writer is not prepared to recommend any one method of mechanical treatment. As in everything else the method must be adapted to the case itself, and not the case to the method.

Some form of traction such as Buck's extension seems to be the preferable method of treatment. If Bardenheuer's suggestion of transverse traction over the ends of the fragments in

order to overcome lateral displacements be added, it will greatly improve the results in many cases. Hamilton's apposition splints placed about the fracture at proper places will serve for this purpose in the majority of cases.

Plaster of Paris is also a valuable means of treating these fractures, but it should be applied under anæsthesia. Complete relaxation, unconsciousness of pain, and laxity of muscle are necessary in applying the plaster dressing properly to these cases.

The usual methods of measurement are very inaccurate and give very misleading records in regard to shortening. This is all the more the case because of the well-established anatomical fact that femurs vary in length, and rarely are two lower extremities exactly the same. Records show good functional results after apparent shortening of extremities up to an inch and a half. The results may be considered good if the measurements show no more than an inch of shortening, provided there is no inversion or eversion of the foot from angulation of the fragments.

The ordinarily employed method of measuring from the anterior superior spine of the ilium to the tip of the internal malleolus should be checked as a rule by some other measurement, as for instance measuring from the tip of the ensiform cartilage to the internal malleolus or patella, or from the middle of the umbilicus to the internal malleolus. In making all measurements it is important to ascertain and assure if possible that the pelvis is not tilted and that the anterior spines are in the same horizontal plane.

My thanks are offered to the following surgeons who answered my questions in regard to fractures of the shaft of the femur: George E. Brewer, George S. Brown, Joseph D. Bryant, A. T. Cabot, Duncan Eve, F. H. Gerrish, John H. Gibson, M. L. Harris, Richard H. Harte, T. W. Huntington, August F. Jonas, Walter Lathrop, Robert G. LeConte, G. H. Monks, John C. Munro, Edward H. Ochsner, A. Primrose, Joseph Ransohoff, John B. Roberts, Charles Scudder, Harry

M. Sherman, Charles E. Thompson, George T. Vaughan, A. VanderVeer, DeForrest Willard, Frank R. Bunts, L. L. McArthur, John B. Walker, and Edward Martin.

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SAFETY IN THE OPERATIVE FIXATION OF INFECTED FRACTURES OF LONG BONES.*

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ACCURATE fixation is fully as important in the presence of infection with fractures as it is in aseptic cases. Realizing that infection nearly always prevents any foreign body from healing in and becoming encysted, I have during the past year given some attention to the selection and employment of temporary apparatus for direct operative fixation, this apparatus to remain in the tissues only until plastic exudate would make it possible to retain satisfactory position after its withdrawal.

Since perfect drainage is a *sine qua non,* the operative wound should be treated without closure or suture of any kind. On the contrary it had best be packed as if an acute osteomyelitis already existed. This will act either as a prophylactic against the extension of bone infection, or in the event of spreading osteomyelitis being already present it will do what ought to be done in the circumstance, that is, it will secure the drainage of the soft parts and will tend to limit the septic process in the bones.

Obviously in these infected cases an intramedullary splint of any sort is contraindicated, and the use of a Lane's plate which assures the absolute reposition of the fragment has the drawback that the removal of the plate when it shall have done its work is an operation of considerable magnitude and no little danger.

The method described by Leonard Freeman in 1904 and again before this Association in 1911 in an essay on the fixation of oblique fractures of the tibia and other bones by means

* Read before the American Surgical Association, May 30, 1912.

of external clamps fastened to screws inserted into the small openings in the skin gave me a suggestive hint. As will be recollected Freeman makes use of two screws set in the bone after the reduction of the fracture and held in place by a clamp running parallel to the broken bone but outside the wound, the clamping bars being placed at the distal extremities of the screws.

Parkhill in 1898 and Lambotte in 1907 wrote on this subject and demonstrated various forms of clamps depending on screws inserted into the bones for their fixation points. Probably the pioneer in this work was Malgaigne.

Taylor, of Port Arthur, Ontario, published a method of fixation somewhat similar to that of Freeman. Taylor put drills into the bone before placing the fragments in position and regardless of alignment. The fracture now being reduced, these drills were held in whatever position they may have assumed by one or more steel bars, placed against their distal parts and held there by a mass of plaster of Paris, thus preventing all motion in the fractured part except a very slight amount which was unavoidable on account of the moderate flexibility or spring of the drills. It has been recommended by most operators to close the wound by suture or otherwise, or else to insert the screws through mere cutaneous punctures and to remove the fixation drills at a suitable time when some union is supposed to have occurred. Doubtless in closed uninfected fractures this method would be quite proper.

During the past year I have made trial of a modification of these methods in six fractures of the long bones, four of which were closed or simple fractures and two open and more or less infected ones. The results on the whole were good as to healing and function. One case, however, in an alcoholic man with fracture of the radius, became infected and there followed some disability because of suppuration between the muscles of the forearm. I have applied the method in fractures of the tibia, the radius, the ulna, and the femur, no case being operated upon until conscientious attempts at reduction had failed. The method which I have used is one which is

extremely simple in its technic and requires such ordinary tools for its successful application that I believe it deserves further trial in suitable cases.

Having exposed the fracture and a sufficient amount of bone above and below it, an ordinary gimlet of a size to fit the case is screwed into one of the fragments at right angles to the long axis of the bone. This gimlet should be fairly close to the fracture but not near enough to endanger the bone by splitting. A second gimlet is now placed an inch or so above the first one. Two other gimlets are similarly screwed into the other fragment about the same distance from the fractured end as were the first two. The gimlet should wedge firmly into the bone so that there will be no play on gentle attempts at motion. It is not necessary to pay attention to alignment. The gimlets being in place, reduction is effected under the eye and the bone held in proper position either from without by an assistant or more directly with the aid of bone clamps. Now two pieces of steel rod about the thickness of small telegraph wire are applied in such a way along the line of gimlets and roughly parallel to the bone that the rods and gimlets shall be in contact. If the gimlets were in a perfectly straight line one rod would be sufficient, for it would touch all of them; but the line being a staggering one, two rods will be found necessary. The rods are to be placed rather far from the wound toward the heads of the gimlets. The rods and gimlets are now bandaged solidly together with a few turns of plaster-of-Paris bandage, previously sterilized by baking. In a few minutes the plaster will have set and the rods and gimlets will be one rigid mass, naturally holding the parts in the position in which they were when the plaster set. It will be found that the bone fragments will be held in alignment by this mass of plaster of Paris, rods, and gimlets.

The wound is now disinfected and packed to the bottom with gauze, and a light rigid dressing applied. At the end of two or three weeks the gimlets will have worked loose because of slight motion and osteoporosis adjacent to the metal and may be easily and painlessly removed, the case from now on

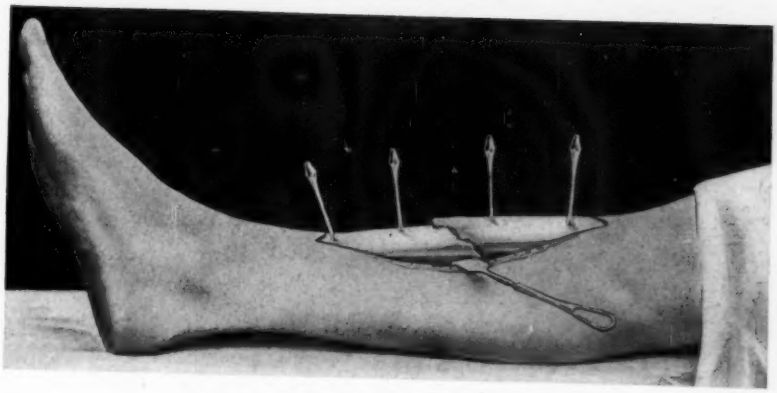
being treated as an ordinary open fracture. The gimlets which proved most satisfactory for this purpose are the ordinary square-headed variety which fit in a brace or which can be put in with a key. If at the end of two or three weeks when the gimlets are removed the wound is found to be aseptic, it may be closed with adhesive strips or sutures. Otherwise open treatment as for any infection should be pursued.

Realizing that a fixation bar or plate transmits its rigidity in inverse ratio to the distance of the plate from the bone, and that when the plate or bar is in contact with the surface of the bone rigid support will be most accurate and that for this reason the Lane plates or their modification are mechanically more perfect than the method I have described and employed, I have devised a modification of the plating method which will combine, it is hoped, the excellent mechanical features of Mr. Lane's beautiful device without the necessity for the removal of the plates in infected cases, an operation of some magnitude.

In other words I wish to present an easily removable modification of the Lane plate and screws (Fig. 8). It will be noted that at the end of the plate there is a little prolongation which is perforated to hold a stout wire. This prolongation is also filed on the bone side of the plate to form a groove so that the wire will not be compressed between plate and bone. The screws and the cone shape of their heads are similar to the Lane screws, but the head is prolonged into a steel shaft of from three to five inches, terminating in a square pyramidal head to fit a key which is to be used instead of the screw-driver. All the steps of the operation of plating a fractured bone will be the same as described by Mr. Lane, excepting that no screw-holder or screw-driver need be used, and that a silver plated piece of piano wire threaded into each terminal aperture in the plate will project from the wound, and that naturally these extension screw heads will also project from the wound.

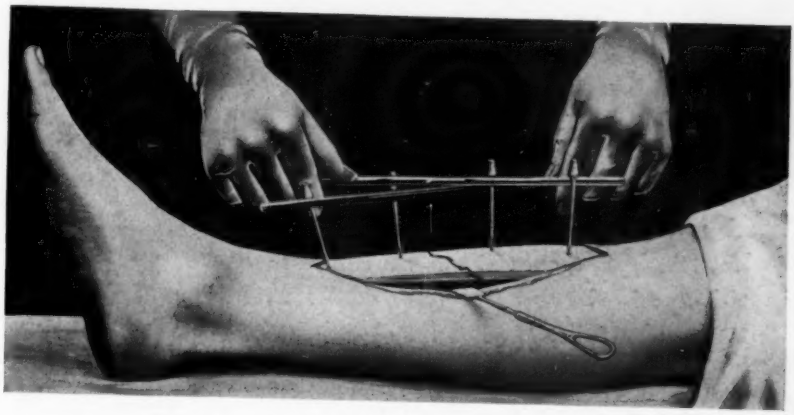
This method being in use for infected fractures, the wound itself will be packed or otherwise drained. After a suitable

FIG. 1.



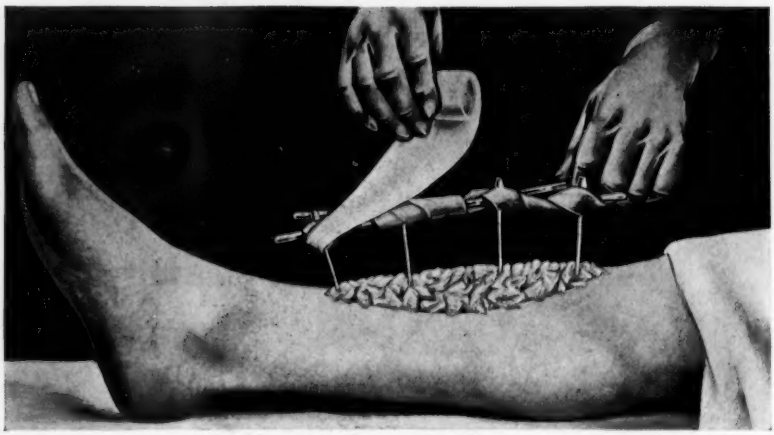
Gimlets in place; fracture not in alignment.

FIG. 2.



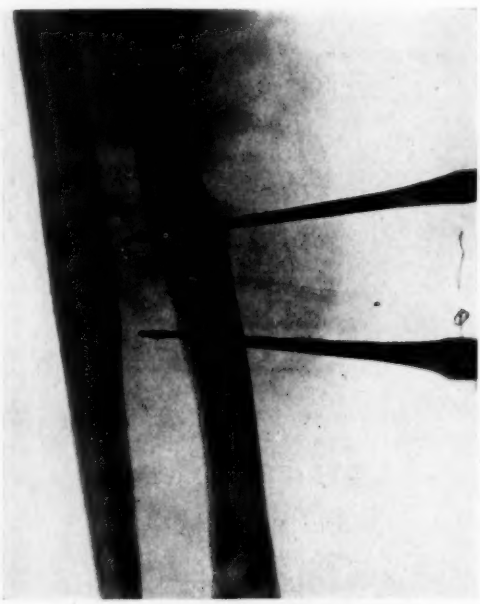
Bones in alignment; bars and gimlets in final adjustment.

FIG. 3.



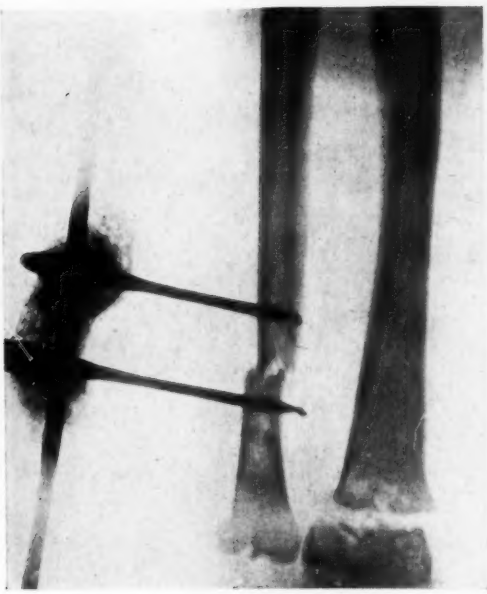
Gimlets and bars being fixed with plaster-of-Paris bandage. Wound packed with gauze.

FIG. 4.



Fragments held in perfect apposition by two gimlets. (Case II.)

FIG. 5.

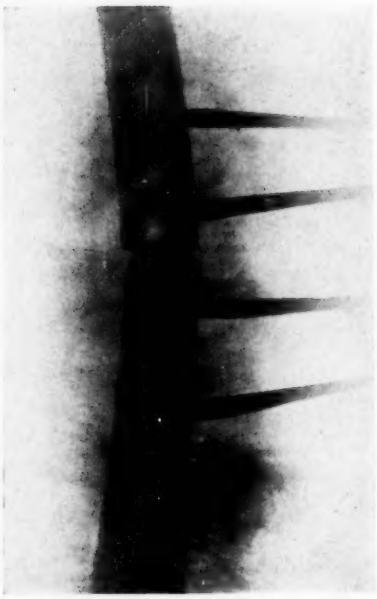


Gimlets applied to ulna. (Case III.)

FIG. 6.

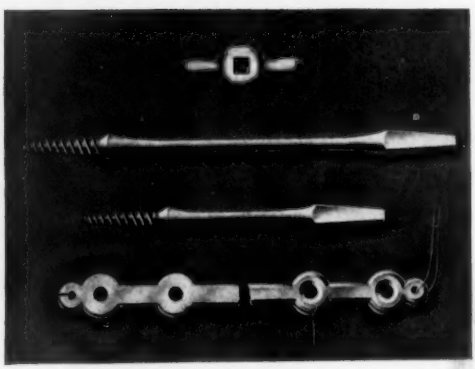
Before operation, but after attempted reposition. (Case IV.)

FIG. 7.



Slight bowing, but perfect function. (Case V.)

FIG. 8.



Author's modification of plate and screws.

lapse of time, say from two to four weeks, the screws are to be removed with key or wrench and the plate is to be drawn from the wound by one or the other wire. It is expected that some force may be required for this procedure, but it is probable that the removal of the plate will be infinitely easier and speedier by this method than by an operation which means free exposure of the parts, the removal of firmly seated screws with a screw-driver, and the extraction of the plate with forceps. I repeat that it is expected that this form of plate is intended for use in infected fractures only, although it may be found on further trial that the removable apparatus may prove of value in cases not frankly infected but merely suspected at the time of operation.

In a recent conversation with Dr. Garrow, of Montreal, he gave me the history of a fracture of the femur occurring apparently through weakness of the bone due to the presence of screws in a case of a completely healed fracture which he had treated by a plating operation. The patient was a young boy and the second fracture occurred some weeks after he had been discharged from treatment. The occasion of this new fracture was a twist of the limb by a sudden turning of the body and the break occurred not at the point of original fracture but at one of the screw holes.

Now, while the plate is of tremendous value in holding firmly and accurately together the fragments of a recent or ununited fracture, it is self-evident that the mere presence of the screws in the shaft of a long bone must prove a source of weakness, because they mean the persistence of bony defects. With the screws removed these defects would fill with new bone and osseous homogeneity would be restored.

To conclude: In this paper I have tried to emphasize (1) the necessity for full drainage in all septic or suspicious fractures of long bones; (2) I have tried to demonstrate the possibility of the direct operative fixation of infected fractures while securing the necessary drainage; (3) in infected fractures direct fixation by apparatus should be temporary.

ABSTRACTS FROM CASE HISTORIES.

CASE I.—George C., forty-nine years old, admitted to Bellevue Hospital August 3, 1911. Compound fracture of both bones of the leg about two inches above the ankle. Repeated attempts at reduction were vain. Operative fixation of the tibia by the gimlet method. August 24, the gimlets were removed. Afebrile recovery.

CASE II.—Louis N., forty-seven years old, was admitted to Bellevue on September 1, 1911. Fracture of his left radius at the middle third. The fracture could be reduced but could not be held. Operation by gimlet method. One gimlet in each fragment. Apparatus removed on September 19, when the wound was clean, after that infection and deferred healing. Final union.

CASE III.—Margaret R., fifty-three years old, admitted to Bellevue on September 15, 1911. Compound fracture of the lower part of the right radius and ulna. An X-ray three days later showed poor position after supposed reduction. Five days after injury gimlet operation on the ulna by Dr. Burdick at my request. Wound left open. Gimlets removed on October 3, and patient discharged October 13 well, but with a small healthy granulating wound.

CASE IV.—Samuel W., twenty-three years old, was admitted to Bellevue Hospital September 7, 1911. Fracture of femur at junction of lower and middle third, about an inch and a half over-riding. Extension failed and gimlet operation performed one week later, using one gimlet in each fragment. An X-ray five days later showed recurrence of the over-riding through rotation of the gimlets in the bone. A secondary operation was done and two gimlets were now placed in each fragment. Aseptic healing and excellent result.

CASE V.—Peter F., age ten years, was admitted to Bellevue Hospital August 24, 1911. Right thigh fractured in the middle third and over-riding as shown in Fig. 7. Operation September 2, 1911, extension having failed. September 21, gimlets removed. Patient made an uninterrupted recovery.

CASE VI.—Louise G., six years old, was admitted on August 11, 1911. Fracture of the fibula and the tibia in the lower third. Reduction and plaster-of-Paris dressing. X-ray showed poor position. August 24, operation by gimlets. Wound sutured be-

tween the gimlets. September 9, apparatus removed. Wound healed October 1, when patient was discharged well.

NOTE.—On May 20 of this year I had my first opportunity to employ the modified plate and screws which I have described in this paper. The patient was a laborer 26 years old, who had been admitted to Bellevue Hospital the day before suffering from a compound fracture of both bones of the right leg. There was a good-sized wound through which the tibia protruded. Reposition by manual effort was possible, but alignment was difficult to maintain on account of slipping of the fragments. The operation of plating was surprisingly easy, mainly because the screws could be sent home by a simple twisting motion without the slightest pressure. In using a screw-driver a certain amount of pressure is necessary in order to keep the instrument in the slot of the screw. I was astonished to note how easily and yet how solidly the long shanked screws seated themselves.

On May 22, another patient, a man 40 years old, presented himself with a compound fracture of both bones, the tibia being broken about an inch and a half above the malleolus. On May 23, I operated upon this man by the same method and was again delighted with the ease of its application. The first operation was finished in about 20 minutes, and the second in about 15 minutes. Both patients are convalescing comfortably.

I would suggest that in plating operations on subcutaneous bone the screw shanks might be made very much shorter and the idea has also occurred to me that in simple and aseptic cases in which it is desirable to follow the original method of Mr. Lane and allow the plate to heal in aseptically, the screw might be made with a square head to fit the key but without the shank.

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INTRATRACHEAL INSUFFLATION ANÆSTHESIA (MELTZER-AUER).*

OBSERVATIONS ON A SERIES OF 216 ANÆSTHESIAS WITH THE ELSBERG APPARATUS.

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INSUFFLATION anæsthesia administered with the Elsberg apparatus has been employed in 216 cases, in the Second Surgical Division at the Roosevelt Hospital during the past year.

It has been used in a great variety of conditions, in many of which we believe it has special advantages, while in others it is probably no better than other forms of anæsthesia.

I will mention briefly some of its advantages:

1. Even and sufficient oxygenation and ventilation of the lungs with no possibility of obstruction of the upper air passages.

2. Prevention of the inhalation of blood, mucus, vomitus, or other foreign substances into the larynx or trachea by the return current of air around the tube. This is of especial value in operations about the mouth and pharynx. It has made the greatest difference both in the ease of the operation and in the absence of post-operative pneumonia or bronchitis. In the series, among other cases of this type we have had three excisions of the superior maxilla, two cleft palates, one partial excision of the tongue, and one sarcoma of the ethmoid.

The blood and mucus may be sponged from the pharynx at leisure, with the assurance that the return current of air around the tube will absolutely prevent any from entering the pharynx.

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* Read before the American Surgical Association, May 31, 1912.

3. Positive pressure to any desired degree, when one or both pleural cavities are opened by accident or design during the operation, thus eliminating the danger of pneumothorax.

It is my belief that it will supplant both negative and positive pressure cabinets, as it has the great additional advantage of thorough ventilation of the lungs, automatically secured, without reference to the patency of the upper air passages. We have had 12 thoracic operations, mostly empyemas, so that our experience with this phase of the subject is too limited to be of much value, though it has proved most satisfactory in all of our cases.

4. In operations about the head and neck the anæsthetist is out of the way, the field is more easily protected and kept sterile, and above all difficult breathing and obstruction of the upper air passages from various reasons is absolutely eliminated.

In goitre cases and prolonged dissections of glands of the neck it is especially useful.

5. Absolute relief of all strain upon the respiratory apparatus, and consequent relief of much strain and harmful effect of the anæsthesia on the cardiovascular and the central nervous systems. This prevention of the unconscious struggle of the respiratory apparatus against obstruction in the upper air passages and insufficient oxygenation with cyanosis is to my mind one of the most valuable features of the method.

One must needs watch a number of these cases and see the quiet, natural respiratory movements, the good color and peaceful appearance, the steadiness in rate and quality of the pulse through prolonged and difficult operations and in debilitated and feeble patients, to appreciate what this means.

6. Less operative shock: The marked absence of operative shock in the cases of this series is suggestive that in estimating the relative influence of the anæsthetic and operative trauma, too little has been attributed to the former. We are firmly convinced that operative shock, especially in the long and difficult cases, is appreciably less with insufflation anæsthesia.

7. Light anæsthesia: It is practically impossible to over-anæsthetize by this method given with the Elsberg apparatus. The fault if any is on the side of too light anæsthesia. It is a great comfort to the operator in critical cases to feel that with the even, mechanical delivery of ether vapor and air into the lungs, the dangers of over-etherization and insufficient aëration are absolutely eliminated, for this in itself insures the minimum of strain on the circulation and of shock to the central nervous system from the anæsthetic. A few minutes before the operation is finished, the ether vapor is shut off and pure air is insufflated, blowing out all remaining ether vapor from the lungs, and hastening the recovery of consciousness.

8. Safety of the method. We have found the method absolutely safe and have seen no harmful results of any consequence in the cases of this series. It is not fool proof, however, and certain cardinal principles must be thoroughly understood and carefully guarded in its administration. These will be referred to in discussing the technic and the difficulties and defects of the method.

Intubation.—The patient must first be anæsthetized in the usual way and fairly well relaxed, to prevent movements of the pharynx and laryngeal spasm while intubating. The procedure is difficult in a small percentage of cases. It is done through the Jackson direct laryngoscope, the head hanging over the end of the table and supported by an assistant. A silk elastic catheter, No. 24 F., is the size used for the average adult. It must be firm enough to hold its direction and not sag downward, or it will enter the œsophagus. It should be marked at 26 cm. and not inserted farther than this point from the incisor teeth. The tip is then one to two inches above the bifurcation of the trachea (Elsberg). In adolescents and small adults the catheter should be smaller in calibre, *e.g.*, 22 F. to 18 F., *i.e.*, its diameter should not be greater than half the diameter of the glottis. No. 26 F. is occasionally used in very large adults. A good view of the vocal cords should be obtained through the laryngoscope, before any

attempt is made to pass the tube. We have found that when one man has failed to intubate after several attempts, another, no more skilful, will often try and succeed at once. Soreness of the pharynx and pain on swallowing has been caused in a few cases by direct trauma from the laryngoscope after repeated attempts in difficult cases. In a few cases (7 or 8), mostly in our early cases, we failed to intubate, giving up the attempt rather than prolong the preliminary anæsthesia and traumatize the pharynx. When the tube enters the larynx there is usually a characteristic sound in expiration, which means a successful intubation. In light breathers this is not always the case and several times we have passed the tube into the œsophagus, without recognizing it until the current of air was started. Generally the expiratory current of air through the tube can be detected by a little fluff cotton held near it, by holding the tube near the cheek, or near the surface of water in a small cup or glass. The movement of the mercury in the manometer with respiration is also a guide but not infallible. Sometimes in spite of precautions it is found after the current is started that the tube is in the œsophagus. By exposing the upper abdomen and watching the epigastric region, the distention of the stomach is readily detected in a few moments, belching of air occurs with a characteristic sound, the tube is disconnected immediately but not withdrawn until gentle pressure over the stomach has forced out the air, and the intubation is repeated. This precaution should always be taken when the position of the tube is in doubt. No ill effects have ever been seen by us from this mishap, but it is quite possible that carelessness might bring about over-distention of the stomach and a harmful result.

The intubation is done, and the anæsthetic administered by my hospital internes, all of whom become proficient in the method in a surprisingly short time.

We have tried the Boothby-Cotton curved intubator with little success, and agree with Elsberg, who has experimented

with various devices, that the direct laryngoscope is the best method tried up to the present time.

Over-pressure.—A cardinal principle of the method is that the degree of pressure should always be carefully watched and absolutely under control. The average pressure in the tube during anæsthesia is 18 to 25 mm., being much less of course in the trachea and bronchi. It may be increased to 35 or 40 mm. without danger in difficult cases, anything below 50 to 60 mm. being considered by Meltzer to be absolutely safe. Every minute or two it is reduced to zero for a moment by opening a stop-cock, to allow the lungs to deflate. The anæsthesia should never be continued if the manometer is out of order, or for any reason the exact pressure is not known and under control. It is well to have a safety valve attached to each apparatus.

Insufficient Anæsthesia.—In alcoholic robust adults it may be impossible to secure a sufficient degree of anæsthesia to relax the muscles or even to keep the patient quiet enough to proceed with the operation. In three cases it had to be abandoned on this account; in seven others it was troublesome, but not enough so to seriously impede the operation. In the remaining 206 cases, the anæsthesia was satisfactory and relaxation good.

A preliminary hypodermic of morphine ¼ gr., atropine 1/150 gr., which we now give as a routine to all robust adults, aids in securing a satisfactory degree of anæsthesia. Proper regulation of this dose should make good anæsthesia and relaxation possible in all cases.

Cough.—In a few cases this is troublesome when the ether vapor is turned on. If the tube is inserted too far, its tip irritating the tracheal or bronchial walls near the bifurcation, withdrawal for an inch or so will often stop the cough. If this fails and the cough is due to too light anæsthesia, increasing the strength of the ether vapor and raising the pressure somewhat may be effective.

Hiccough.—Hiccough was present in two cases, in one for a short time at the beginning of the anæsthesia, in the other

throughout the operation. In neither was the operation interfered with.

Vomiting was present in 51 of the 216 cases, 23.6 per cent. It was slight in 29 cases, moderate in 18, severe in four. All of the latter were severe abdominal cases vomiting prior to operation.

The method was used once in a case of stricture of the larynx, the tube being passed through a tracheotomy wound and anæsthesia induced without preliminary etherization. There was some cough and it took about twenty minutes to get the patient under the anæsthestic.

We have used the apparatus for resuscitation in a case brought into the emergency ward, deeply cyanotic, gasping infrequently, pulseless at the wrist, and apparently dead before the intubation was completed. In a few minutes the cyanosis disappeared, respiration was re-established, and in less than half an hour the patient was sitting up in bed quite over the attack. Examination then showed a large thoracic aneurism, and three days later the patient died in a similar attack, the insufflation this time proving ineffective.

After-effects.—In regard to after-effects, the most natural to fear are pneumonia or bronchial irritation.

Pneumonia: There has been no ether pneumonia in the series. Two patients had post-operative pneumonia, but in neither could the anæsthetic be held responsible. One, an obese, debilitated old man on whom suprapubic prostatectomy was performed, developed a late, hypostatic pneumonia some days after the operation, which finally subsided and a good recovery followed. The other case, operated upon for perforated duodenal ulcer, peritonitis, and general sepsis, desperately ill at the time of the operation, ran a long course of sepsis from which he finally died, of which a right lower and middle lobes pneumonia was one of the manifestations. After a careful consideration, we did not feel that the pneumonia in this case could in any way be charged to the anæsthetic.

During the period in which we have been using insufflation

anæsthesia, we have had four or five ether pneumonias on the Division, but all in cases in which other methods of anæsthesia were used.

Bronchitis: There have been no cases of ether bronchitis. In a few cases with slight bronchitis at the time of operation, there was little if any increase of the cough, none developing any decided aggravation of the condition.

Laryngitis: There has been no post-operative laryngitis or hoarseness.

Pharyngitis: This has been noted in seven cases. In three there was marked discomfort and difficulty in swallowing for from one to three days. In one case in which the attempt to intubate was abandoned after a prolonged trial, the soreness persisted for a week. Difficult intubation and direct trauma to the pharynx and epiglottis with the laryngoscope was the cause in all of the cases. In none was the result anything more than a few days of discomfort.

Injury to teeth occurred in three cases: in one an incisor tooth loosened, in the other two some fragile bridge work was broken.

In a series of 216 cases, we have considered the method of special advantage in many cases, some of which I will mention, viz.:

	Cases
Goitre	5
Exophthalmic goitre	4
Tuberculous glands of neck	25
Resection of superior maxilla	3
Sarcoma of ethmoid (2 hours)	1
Cleft palate	2
Excision of tongue	1
Pyopneumothorax (following bullet and stab wounds of lungs)	2
Old empyema, abscess of lung	6
Subphrenic abscess	3
Miscellaneous operations about the head and neck	13
Operations upon the breast	9
Prostatectomy	5

It has also been employed in 68 abdominal operations, including many desperate and difficult cases in which the quiet

and even anæsthesia, with absence of anæsthetic shock and depression, has been a great comfort to the operator and added element of safety to the patient. One case, a very obese woman with ventral hernia, strangulated for four days, with fecal vomiting and practically pulseless at the wrist on admission, died on the table, but was in no sense a death from the anæsthesia, as pure air and not ether vapor was used the greater part of the time during the forlorn attempt to relieve the condition.

In some cases of acute intestinal obstruction and diffuse peritonitis with profuse vomiting before and during operation, it has been of value in preventing the inhalation of vomitus, as well as in giving even, quiet anæsthesia under the most trying conditions.

There have also been 13 operations on the kidney and ureter, in which, on account of the awkward position, the anæsthesia has been much less troublesome than with the routine method.

CONCLUSIONS.

1. Insufflation anæsthesia is safe if certain cardinal principles are observed in its administration, *i.e.*, one must guard against over-pressure, spraying of liquid ether through tube, introduction of tube into œsophagus, introduction of tube beyond bifurcation of trachea, and trauma to pharynx or larynx in intubation. A proper apparatus and ordinary caution should absolutely prevent the accidents which have been responsible for the few reported deaths from the method.

2. The uniformly sufficient aëration of the lungs, with the even administration of well-diluted ether vapor, relieves the respiratory apparatus and central nervous system of much strain, and over-etherization is impossible.

3. The prevention of the inhalation of blood, mucus, or vomitus, especially in operations about the mouth and pharynx, is an important feature in preventing inhalation pneumonia or bronchitis, and in making such operations easier and more rapid.

4. Operations about the head and neck are made much easier, as the anæsthetist is out of the way, the field is easily kept sterile, and above all obstruction of the upper air passages is eliminated.

6. The insufflation of pure air at the end of the operation makes recovery of consciousness prompt, and disagreeable ether after-effects are reduced to a minimum.

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Annals of Surgery,
227–231 South Sixth Street,
Philadelphia.